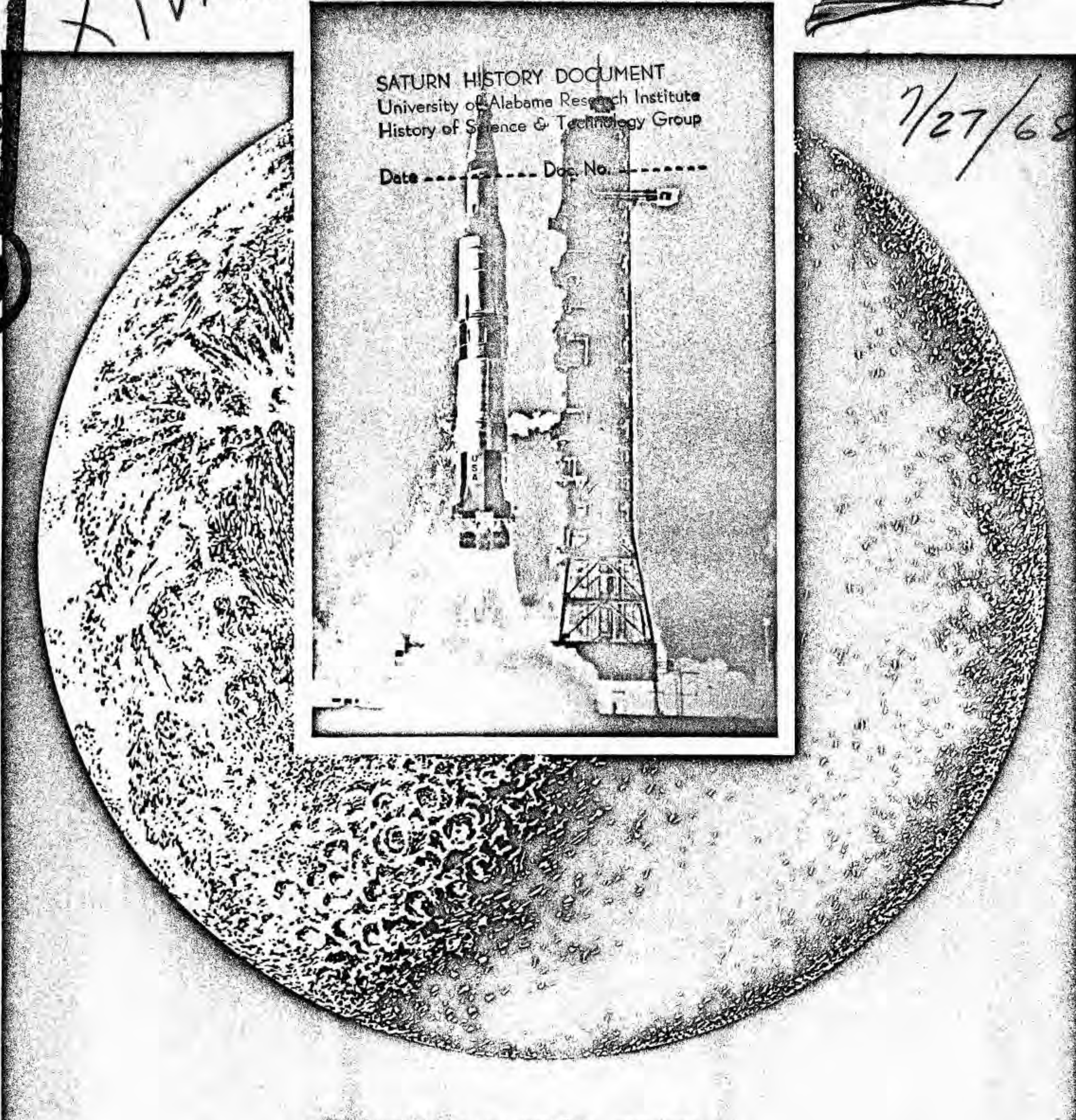

SATURN V FIRST STAGE

annual progress report

FISCAL YEAR

1968

THE BOEING COMPANY / SPACE DIVISION / LAUNCH SYSTEMS BRANCH

ANNUAL PROGRESS REPORT

JUNE 30, 1967 THROUGH JUNE 27, 1968

CONTRACT NAS8-5608, SCHEDULES 1 AND 1A

JULY 27, 1968

LAUNCH SYSTEMS BRANCH
SPACE DIVISION
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FOREWORD

The Annual Progress Report has been prepared by The Boeing Company to fulfill the requirements of IN-I-V-S-IC-67-10, "S-IC Program Deliverable Data," Line Item 22, Document Requirement Description MA-509C of Contract NAS8-5608.

This document reports progress made by The Boeing Company on the Saturn S-IC program for FY 1968 (June 30, 1967, through June 27, 1968) pertaining to Schedules I and IA of the contract.

Progress is reported by contract part in accordance with NASA/MSFC instructions. Activities that encompass more than one contract part are reported under that part considered to have the major role.

This report includes the following subjects:

- Project Management
- Contract End Items and Services
- Facilities Planning and Activation
- Logistics
- Stage System Studies
- Launch Operations
- Advanced Studies

SUMMARY

During FY 1968 several major Saturn/S-IC program milestones, which were of utmost importance to the Apollo program's mission of placing men on the moon, were achieved. The most significant milestones reached were the successful launchings of the first and second Apollo/Saturn V vehicles, AS-501 and -502, from the Kennedy Space Flight Center. The AS-501 was launched from Kennedy Space Flight Center at 7:00:01 a.m., EST, on November 9, 1968. The S-IC-1 and its Boeing Schedule I supplied ground support equipment performed exceedingly well during launch and flight. AS-502 lift-off occurred at Kennedy Space Flight Center at 7:00:01, on April 4, 1968. Performance of all systems on the S-IC-2 and its Boeing Schedule I supplied ground support equipment was satisfactory during launch and flight. However, longitudinal oscillations (POGO) were experienced during flight. Boeing is expending every effort to alleviate this phenomenon in all future S-IC flights.

Subsequent to the launch of AS-501 and -502, the decision to make AS-503 the first manned Apollo/Saturn V mission was reached. The first stage for this mission, the S-IC-3, is the first Michoud assembled S-IC flight stage. This vehicle was accepted by NASA during FY 1967 and then placed in storage at Michoud. It was later removed from storage, retested, and shipped to Kennedy Space Flight Center, arriving there on December 27, 1967. At the close of the reporting period, the S-IC-3 was at Kennedy Space Flight Center where it is undergoing extensive modification in preparation for the first manned launch.

Other significant S-IC program incentive milestones achieved during 1968 include delivery of the S-IC-4 to the Customer, on-dock Michoud, on August 28, 1967; successful static firing of the S-IC-5 at the Mississippi Test Facility on August 25, 1967; and successful completion of the S-IC-6 and -7 post-manufacturing static firing readiness tests on July 24 and November 12, 1967, respectively.

Boeing/Michoud testing programs were conducted throughout the year with the purpose of resolving design data problems, discrepancies, and anomalies identified during manufacturing, static firing, and AS-501 and -502 launch support operations. Major testing programs that were conducted on a continuing basis included the reliability, qualification, development, and failure analysis test programs.

Project management techniques, designed to assure efficient and effective management of the S-IC program, were under constant surveillance throughout FY 1968. An S-IC Integrated Safety Program, which is responsive to both Boeing Corporate policies and NASA requirements, was established during October of 1967. This program combines and integrates the previously separate industrial and systems safety plans into one overall safety program, and is overseen by the S-IC Safety Board that meets on a regular basis to provide program direction. This arrangement provides for a single safety focal point for increased Management control and improved visibility of safety performance versus assigned tasks, thereby assuring safety excellence in all phases of the S-IC program.

Throughout FY 1968 management reviews, concerning all aspects of the S-IC program, were conducted. Among these reviews were the three contractually required S-IC Technical Progress and Program Reviews that were conducted to inform NASA personnel of Boeing's progress and performance on Contract NAS8-5608. Internal Boeing Management reviews during the year included periodic meetings of the Saturn Performance and Saturn Launch Readiness Boards. These Boards are made up of Boeing executives from affected Boeing/Saturn programs and have as their mission assurance of proper performance of all Saturn contractual obligations.

Personnel reassignments and organizational restructuring continued throughout the year with the purpose of assuring effective management of the S-IC program. Of major significance was the relocation of the Boeing S-IC Systems Test Manager's office from Michoud to the Mississippi Test Facility. This relocation was made to enhance the coordination between Boeing Management and the NASA Mississippi Test Facility Management.

PROJECT MANAGEMENT

1

SUMMARY

Project Management activities during the year were directed toward managing the S-IC program to assure optimum utilization of resources and the attainment of significant milestones including all contractually required obligations.

During FY 1968 long-lead procurement for stages S-IC-16 and -17 was initiated under Contract NAS8-19544. This contract was executed on July 25, 1967, terminated at the convenience of the government on October 16, 1967, and reinstated on March 8, 1968.

Because S-IC stages were being produced at a greater rate than they could be effectively utilized, revised program schedules and guidelines were received during the year. Boeing agreed to these revisions subject to an equitable adjustment to the Contract, and on November 13, 1967 Supplement Agreement MICH-662 formally placed the Apollo Program 4H schedule on contract. Negotiation of MICH-662 began on June 17, 1968 and was continuing at the end of the reporting period. On June 14, 1968 Supplemental Agreement 777, which contains the Apollo Program 4I Schedule, was received from NASA. Negotiation of this new schedule will begin "immediately following" completion of MICH-662 negotiations.

The Michoud Cost Effectiveness Program was established during the reporting period. Activities under this program are directed toward identifying, evaluating, and implementing changes that reduce the total cost of the S-IC stage and derivatives. The Michoud Cost Improvement program also continued to operate effectively throughout the year with a reported validated cost savings of $14,200,788 as compared to a goal of $9,585,740.

The Boeing/Michoud work force underwent adjustments during this fiscal year to compensate for the reduction in activity resulting from schedule slides. The work force reporting to the Boeing/Michoud manager was reduced by 833 which resulted in a total workforce of 4254 at the end of the fiscal year. Various Boeing/Michoud personnel were also placed on loan to alleviate manpower problems at other Boeing Saturn locations.

Efforts were made to assure that Plans for Progress and Equal Employment Opportunity programs continued during the reporting period. As a part of this program an Equal Employment Opportunity Administration function and an Equal Employment Opportunity Committee were established to promote equal opportunity.

CONTRACTING ACTIVITY

CONTRACT DELIVERY SCHEDULE

During 1967, it became increasingly apparent that S-IC stages were being produced at a rate greater than the Apollo Program could effectively utilize. On September 1, the NASA Contracting Officer gave official recognition to this fact by a letter requesting immediate implementation of certain "revised program guidelines." On September 12, Boeing agreed to proceed with a revised plan subject to an equitable adjustment of the contract. On November 13, Supplemental Agreement (SA) MICH-662 formally placed the new 4H Schedule on contract.

A further schedule slide identified as 4I was contractually implemented by SA 777 on June 14, 1968.

On June 17, 1968, negotiation of the 4H Schedule (SA MICH-662) was initiated based on cost proposals submitted in February and March 1968. Both parties have agreed to negotiate the further impact of SA 777 "immediately following" the conclusion of the SA MICH-662 negotiation.

NASA PROCUREMENT REORGANIZATION

In early 1968, informal conversations with NASA/ Michoud contracting personnel indicated that the procurement function for S-IC stages would be moved to MSFC in Huntsville, Alabama. This was done on April 1, 1968. As a result, Boeing/Michoud Contracts has established and staffed the "Huntsville Representative" office to maintain liaison with the NASA procurement function. The transition has been made without major perturbations, and it is believed that, other than the increased travel by Boeing/Michoud Contracts personnel, no impact will result.

CONTRACT MANAGEMENT

CONTRACT NAS8-2577

In a letter dated February 1, 1968, NASA formally acknowledged accomplishment of the performance requirements and administrative actions necessary to close out this contract. Final payment was received on February 5, 1968.

CONTRACT NAS8-5606(F)

This contract covers special facilities equipment for the Saturn S-IC program. The requirements for such equipment are established by program needs and submitted to the government in the form of a fiscal year plan. The forecast is negotiated and the necessary level of funding is placed on contract. During FY 1968, funding of the facilities contract was increased in the amount of $930,000.

CONTRACT NAS8-5608 (SCHEDULES I & AND IA)

During this reporting period, the following schedule and performance incentive milestones were accomplished under Schedule I of the contract:

July 24, 1967	Successful completion of the S-IC-6 stage post-manufacturing static firing readiness test for full (299.6) incentive points
August 25, 1967	Successful static firing of the S-IC-5 stage for maximum (260) incentive points
August 28, 1967	Acceptance by the Government of the S-IC-4 stage for 3494.6 out of a possible 3498.6 incentive points

For the above milestones, a total of 4,054.2 of a possible 4,058.2 incentive points were earned.

November 13, 1967	Successful completion of the S-IC-7 stage post-manufacturing static firing readiness test for maximum incentive points. The incentive points earned on this milestone are being held in abeyance pending revision of contract schedules and incentive arrangements in accordance with SA MICH-662.

CONTRACT NAS8-5608 (SCHEDULE IB)

On February 15, 1968, Schedule IB to Contract NAS8-5608 was established for the purpose of providing documentation, modification kits, and parts to support the S-IC-T stage and the Systems Development Facility Mechanical Automation Breadboard (MAB. The new schedule was fully funded in the amount of $170,000.

CONTRACT NAS8-17218

The technical work statement has been completed. To effect contract closeout, letters of cerfification and other evidence of contract completion are being provided to the Contracting Officer.

CONTRACT NAS8-19528

The technical work statement has been completed. In order to effect contract closeout, letters of certification and other evidence of contract completion are being provided to the Contracting Officer.

CONTRACT NAS8-19544

This contract for the procurement of long-lead items for stages S-IC-16 and -17 was executed on July 21, 1967. Notice of Termination for the convenience of the Government was received from NASA on October 16, 1967. All organizations, including Seattle and Wichita, reported work stopped within the required five-day period. On February 21, 1968, Boeing was informed that NASA Headquarters had approved reactivation of Contract NAS8-19544. SA No. 2, received (fully executed) on March 8, 1968, officially reinstated the contract. This SA provided for:

a) Cancellation of the Notice of Termination;

b) Reinstatement of the long-lead effort previously authorized by the contract;

c) Adjustment of the contemplated delivery dates for stages S-IC-16 and -17 to July 1, 1971, and January 1, 1972, respectively; and

d) Extension of long-lead effort through July 31, 1968, with provisions for negotiation of a monthly extension to March 31, 1969.

CONTRACT ACTIVITY FY 1968

A summary of contract modifications, proposals submitted, negotiations completed, and deliverable data submitted are set forth in Appendices A, B, C, and D.

PROGRAM PLANS, SCHEDULES AND REPORTS

PROGRAM SCHEDULES

Document D5-11040-5, "Launch Systems Branch S-IC Project Contractual Schedules," superseded D5-11040-4 and was published during the previous reporting period (June 13, 1967). This document outlines the LSB S-IC project contract schedule for stages S-IC-3 through -15 as set forth in CPIF Contract NAS8-5608 (Schedule I and IA), and S-IC Stage Development and Delivery Plan, MA-2 Schedule, Plan VIIIA, which is published by the NASA/MSFC S-IC Project Office. This schedule data establishes the contractual parameters for development of LSB S-IC Plan VIIIA Internal Working Schedules. During FY 1968, one revision was made to D5-11040-5. This revision adjusted contract schedule milestones on S-IC-3, S-IC-5, S-IC-6, and S-IC-7 as directed by the customer and added the period of performance for procurement of long-lead items authorized by CPIF Contract NAS8-19544 for S-IC-16 and -17.

Document D5-12535, "S-IC Program Reporting Milestones," identifies and provides schedule dates for the S-IC program milestones used by Boeing in reporting the progress of Contract NAS8-5608, Schedules I and IA, to MSFC. The milestones set forth in this document were established through mutual agreement between Boeing and MSFC to establish a common reporting baseline by which program progress could be measured. Revision "L" to D5-12535, released October 31, 1967, (1) incorporated a revised format, (2) added reference milestones for MSFC produced stages (S-IC-T, S-IC-1, and S-IC-2) and the dynamic test stage (S-IC-D), (3) added reporting milestones for stages S-IC-11 through -15, and (4) deleted reliability and logistics program reporting milestones. In accordance with revised reporting frequency from "as required" to "once every two months," three additional revisions, "M," "N" & "O," were prepared and released on December 21, 1967, February 28, 1968, and April 22, 1968, respectively. Revision "M" and "O" incorporated minor schedule revisions and added actual completion dates for closed out milestones. Revision "N" implemented a completely revised interim schedule, in lieu of a negotiated contract schedule, based on required on-dock Michoud delivery dates contained in Supplemental Agreement MICH-662. Revision "P" is presently being prepared and is scheduled for release during July 1968. This revision will update the interim schedule to be compatible with the internal working schedule released June 17, 1968.

D5-13595, "S-IC Turn-Around Equipment Schedules," serves as an instrument of agreement between MSFC and Boeing on the requirements for and utilization of turn-around equipment at the Michoud Assembly Facility, Mississippi Test Facility, Marshall Space Flight Center, and Kennedy Space Center. Turn-around equipment is defined as those major items of equipment, regardless of complexity, that are reused in the assembly, handling, testing, and transporting of S-IC stages. Revisions "C" and "D" to this document were released July 31, 1967 and March 5, 1968, respectively. Both were complete revisions re-aligning turn-around equipment utilization requirements to be compatible with revised stage internal working schedules.

LSB S-IC Internal Working Schedules, released by Program Letter through the S-IC Program Executive's office, are issued to establish real-time schedule milestones and organizational work interfaces to ensure stage production and test continuity. Three revised working schedules (schedule No.'s 103, 104, and an interim schedule pending negotiation of a possible schedule No. 105) were released during this reporting period. Working Schedule No. 103 was released, July 3, 1967, to reflect revised end-item delivery requirements for S-IC-5 and -6 and adjusted schedule dates for completion of PMC for S-IC-7 in accordance with negotiated schedule changes. Working Schedule No. 104 was issued January 5, 1968 to reflect internal schedule realignment necessary to support the revised delivery requirements for stages S-IC-3 through -14, which were contained in Supplemental Agreement MICH-662. An interim working schedule was published May 28, 1968 to provide transitory schedule direction pending negotiation of a revised delivery schedule. MICH-662 delivery requirements were invalidated by customer issuance of stop work orders on S-IC-5 and -6.

PROJECT PLAN

Document D5-11960, Revision D, "S-IC Stage Project Management Plan," published in June 1967, presents a summary view of the organization, planning, and methods used by the Boeing Launch Systems Branch to provide the most effective means of completing the S-IC project within the schedule and cost goals established by Contract NAS8-5608, Schedules I and IA.

The contractual requirements for a semi-annual updating of D5-11960, during this reporting period, were changed to an "as-required" basis by Supplement Agreement MICH-310.

PROGRAM ASSESSMENT AND PERT SYSTEM

The Saturn V/S-IC Launch Systems Branch PERT System report presents milestone status measured against the currently approved plan. This report is produced bi-weekly. Items that are behind schedule are identified by the PERT system and are called to the attention of management through PERT assessment meetings which are held bi-weekly. PERT computer printouts are also forwarded to designated representatives in each affected organization.

A number of new innovations have been adopted that reduced the manpower required to support the current level of reporting effort. The major changes included:

a) The substitution of Saturn Apollo Reporting Procedure (SARP) charts with a form cover letter for formal bi-weekly reports to the customer;

b) A set of trend charts and a short resume of major problems that are displayed in the Status Display Center (see Management Control Centers, page 6) were adopted instead of a formal bi-weekly report to Boeing management; and

c) A computer program was developed to automatically construct logic networks from the biweekly master PERT tape. These networks, produced for approximately $.05 each, provide a graphic image of the computer tape. This greatly reduces the human error and time required to maintain a history of program accomplishments.

MANAGEMENT CONTROL CENTERS

The Boeing Program Control Center (PCC) (Figure 1-1) provides management with current status of S-IC program schedules, events, and items of concern. The items displayed assist management by depicting the status in a concise manner for rapid comprehension. Among the many changes to the PCC which resulted in increased effectiveness was the installation of ultraviolet lighting during FY 1968. Fluorescent materials are used along with the lighting for vivid portrayal of schedules, event sequences, and other items displayed to aid management.

During FY 1968, an area of the PCC was devoted to Resources Status. Items displayed included manpower, long-lead procurement and budget status. This coverage of resource items will continue to aid in planning future program activities.

The Boeing Status Display Center (SDC) was utilized in FY 1968 to provide real-time tracking for management visibility of stage and GSE open items prior to the launch of S-IC-1 and -2. The viewgraphs displayed in the SDC were also used to provide the latest S-IC status during the Stage Manager's Pre-Flight Reviews, the Program Manager's Pre-Flight Readiness Reviews, MSFC Pre-Flight Reviews, Launch

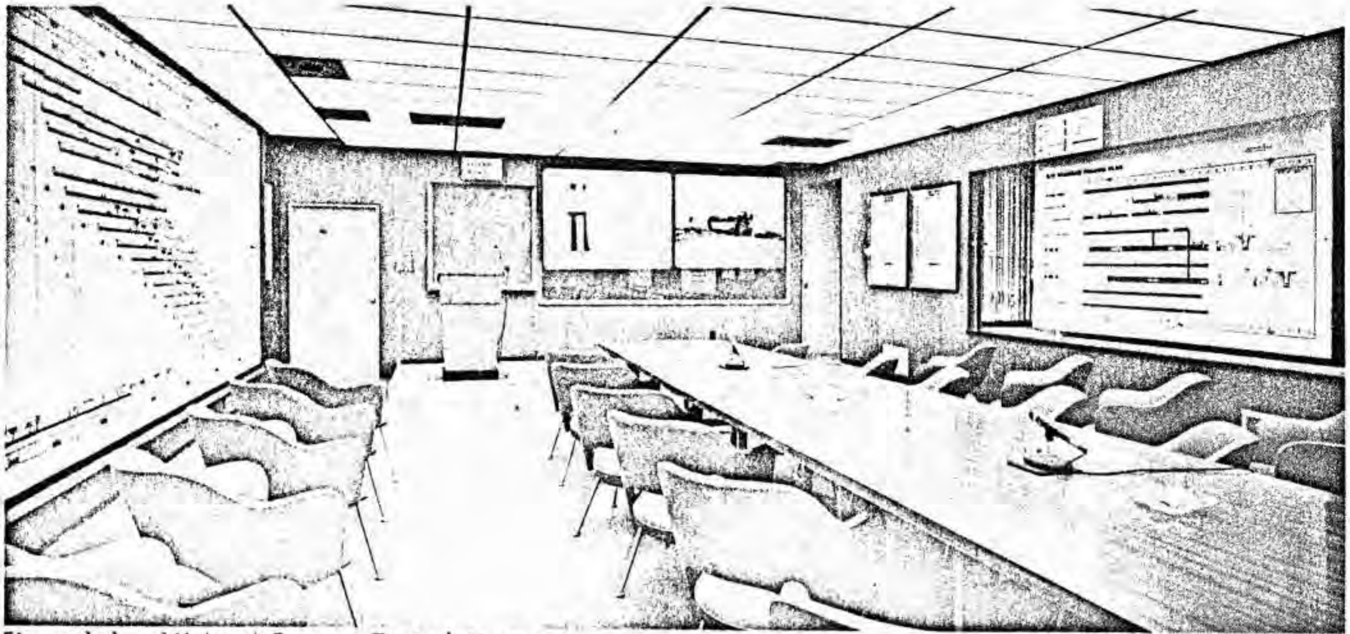


Figure 1-1 Michoud Program Control Center

Readiness Reviews, the Apollo Flight Readiness Reviews, Launch Readiness Board meetings, and other reviews held at MSFC and BATC. The information on the viewgraphs was also transmitted to BATC to inform them of the latest status of hardware for retrofit changes. The status of the S-IC-3, -4, and -5 and associated GSE, MTF, Mechanical Automation Breadboard (MAB) and PERT delinquency status is currently displayed in the SDC.

The Michoud Morning Report is published daily to augment the S-IC program information that is displayed in the PCC and SDC and to inform management of the significant events occurring at Michoud.

The Management Information Center was established in August 1966 upon completion of the "In-Depth Analysis" of the Michoud organization. This study was initiated to provide an assessment of individual skills and organizational structuring against tasks to be performed. This data is maintained on a current basis and displayed in the Management Information Center. Another important use for this center is the availability of comprehensive personnel data and special display material applicable to equal employment opportunities. These displays have been reviewed by visiting personnel from the Equal Employment Opportunities Commission and have proven fruitful in assuring the commission of Boeing responsiveness to equal opportunities for all employees.

MANAGEMENT REVIEWS

TECHNICAL PROGRESS AND PROGRAM REVIEWS

Customer requirements for S-IC Quarterly Reviews were reduced from four to three per year in FY 1967. This requirement remained constant for FY1968. The 18th, 19th, and 20th S-IC program reviews were conducted in FY1968.

The 18th Technical Progress and Program Review was held at Michoud on July 26, 1967 and reviewed the status of S-IC stages and related activities, particularly S-IC-1 flight readiness. Technical problem reviews covered the need for test data on the characteristics of the Slow Release Mechanism and its effect on AS-501 launch, environmental control system incompatibility, and potential stage and GSE changes.

The 19th Technical Progress and Program Review conducted at Michoud on December 14, 1967 concentrated on AS-501 (S-IC-1/GSE) prelaunch and flight performance. Anomalies that occurred during prelaunch and flight were discussed and recommendations were made for a number of S-IC instrumentation modifications necessary to obtain technical performance data on subsequent flights. Other problem areas reviewed included configuration differences between S-IC-1 and -2, qualification tests and certifications remaining and the reliability test program. The review ended with a discussion on how configuration management might be improved between Boeing and MSFC.

The 20th Technical Progress and Program Review was held at Michoud on June 6, 1968. Major items covered in the meeting were S-IC-2 Pre-Launch and Flight Performance, and significant preflight and flight anomalies, with emphasis on the LOX vent and relief valve position switch and POGO. Other important items reviewed were S-IC-3 manned configuration change status, S-IC stage distributor rework plan and schedule, test and retest quality verification program, and a discussion on the programmed reduction of critical skills in Engineering and Operations.

SATURN PERFORMANCE AND LAUNCH READINESS BOARD MEETINGS

As a part of the Boeing program to assure proper performance of all Saturn contractual obligations, the Saturn Performance and Saturn Launch Readiness Boards met periodically throughout FY 1968. These boards, the membership of which consists of Boeing executives from affected Boeing/Saturn programs, have as their purpose and scope:

a) Saturn Performance Board - examine the activities of The Boeing Company that provide assurance that the Saturn V launch vehicle will perform in accordance the contract performance requirements and the expectations of the customer. The Board is responsible for initiating corrective action as necessary to assure performance adequacy.

b) Saturn Launch Readiness Board - examine the activities of The Boeing Company leading to the preparation of a successful launch of each Saturn V mission. This Board initiates corrective action, where necessary, to assure the maximum effectiveness of Boeing's overall participation in the Saturn V launch program.

The Saturn Performance Board met six times during FY 1968. Some of the topics discussed at these meetings were:

a) The Board reviewed the design, modification, and test programs associated with S-IC pneumatic equipment. As a result of this review, the Board concluded that although this equipment had successfully (without significant delay) supported 20 static firings of the S-IC, it would be required to operate unattended at KSC for long periods of time (4 to 14 hours) and therefore provided the risk of potential launch delay as a result of component failure. The Board further concluded that there were several failure modes for this equipment that could result in the loss of a stage at MTF or a vehicle at KSC, and that there were many failure modes that could result in delay or launch scrub at KSC. As a result of these conclusions, the following action items were assigned to Boeing Schedule I, and these items have been accomplished to the extent possible at this time:

   1) Identify failure modes resulting in vehicle loss and provide the rationale for the acceptability of these risks.

   2) Establish the plan and schedule for the elimination of these critical failure modes in support of the first manned vehicle.

   3) Identify the failure modes that result in launch scrub or delay and provide for the elimination of these or the rationale for their acceptance as risks.

   4) Identify the action necessary to make MTF safe, i.e., so it is not possible to lose the stage through a failure of this equipment.

b) A pre-launch review of Boeing AS-501 and 502 launch critical problems, assessment of the impact of these problems, and assignment of necessary corrective actions.

c) Identification and assessment of the adequacy of those activities that represent the unique requirements to qualify Boeing contracted hardware and test operation for man-rating a specific Saturn mission, including:

   1) Identification of essential requirements that must be met to provide confidence in manned mission success;

   2) Determination if these requirements can be assured by documented analysis and test; and

   3) Determination if the evidence of accomplishment can be accommodated in the Design Certification Review written and oral reports.

During FY 1968 the Saturn Launch Readiness Board met eight times. Discussions at these meetings included:

a) The POGO effect experienced during AS-502 launch and POGO history, possible suppression systems and solutions in work.

b) Discussion and disposition of AS-501 and -502 pre-launch open-work items.

c) Areas of unsatisfactory or marginal performance during the AS-501 flight were reviewed with the purpose of preventing recurrences during launch of the AS-502.

OTHER MANAGEMENT REVIEWS

During FY 1968 Boeing/Michoud orientation and activity reviews were given to many visiting dignitaries. A synopsis of some of these reviews follows:

a) On October 10, 1967 a briefing was conducted for the Sub-Committee for NASA Over-Sight, U. S. House of Representatives (Teague Committee). At this review, the sub-committee was briefed on all Boeing/Saturn V Apollo activities, including Contract NAS8-5608 schedules I, IA, II and III, the Apollo Technical Integration and Evaluation contract (NASW-1650), and New Technology disclosures. Schedule I and IA participation in this briefing consisted of a review of CY 1966 and 1967 schedules, costs, and problems and a preview of anticipated CY 1968 activities. These reviews brought out the fact that Boeing Schedules I and IA are underrunning estimated costs, and that the S-IC production program is well ahead of the contract delivery schedules and Saturn V launch schedules, thus resulting in the necessity to place completed or partially completed stages in storage. Boeing's transition to this reduced activity and the resultant decreased manpower needs were also reviewed for the committee. A review of the complete Boeing presentation to the sub-committee is available in the study prepared for the Subcommittee on NASA Oversight, entitled "Apollo and Apollo Applications," dated February 26, 1968.

b) A short S-IC program briefing was given April 22, 1968 to Dr. Thomas O. Paine, the then newly appointed Deputy Administrator for NASA. He was accompanied by Dr. Wernher von Braun, General O'Connor, and other NASA representatives. They were also given a tour of MTF and Michoud (NASA, Chrysler, and Boeing).

c) On June 6, 1968 a review of the S-IC program was given by Dr. H. E. Newell, Associate Administrator for NASA. The presentation explained Boeing's requirements and major rolls in the Saturn V/Apollo Program, Boeing Space Division organization, a general S-IC stage assembly orientation, and cost performance for Schedules I and IA. The S-IC stage delivery schedule and factory utilization were also discussed. Following the presentation, Dr. Newell was given a plant tour.

EQUIPMENT MANAGEMENT

During FY 1968, the Equipment Management Organization systematically re-evaluated all of its organizational functions and responsibilities to determine if certain organizational tasks were still required and if required tasks are being accomplished in the most efficient manner. Equipment management activities for the year included:

a) The "Associated Contractor Liaison Plan," contract document IN-I-V-S-IC-66-3, equipment management supplied the Marshall Space Flight Center with five data deliveries, including weekly inputs on S-IC equipment acceptance testing. This material will be used in the subject plan;

b) "Rocketdyne Requests For Boeing Support," contract document IN-I-V-S-IC-65-9—Rocketdyne requests for Boeing support increased during the reporting period. Ten Rocketdyne requests were received and all were processed;

c) Control of operating agreements—Action was taken by equipment management to convert all Boeing Schedule I/Schedule II operating agreements to standard command media. Schedule I/Schedule III operating agreement activity continued during FY 1968. This activity increased prior to and after the launch of AS-501 and -502. Schedule I/Schedule III operating agreements were reviewed and updated to correct discrepancies and to cover additional needs that became apparent during launch support. Four new operating agreements were established;

d) "Master Equipment List," Document D5-12888—Equipment management reviewed requirements for ground support equipment, manufacturing support equipment, and all additional equipment. The master equipment list and all associated documents were revised and updated. The purpose of this review was to determine new equipment requirements and to ensure that all delivered equipment was listed in the document.

The result of this study was to provide an accurate and up-to-date listing of Launch Systems Branch S-IC equipment requirements. An additional study was made to reduce document frequency and distribution. As a result, the master equipment list and associated document publications were reduced by 532 per year;

e) "Government Furnished Property," (GFP) Document D5-11044-1—To eliminate duplication that existed due to the publication of two GFP documents; D5-11044-1 (Boeing, and IN-I-V-S-IC-66-1 (contractual), the Equipment Control Board elected to cancel the Boeing GFP document and rely on IN-I-V-S-IC-66-1 as the all-inclusive GFP document. This single document now contains all firm, preliminary, and loaned NAS8-5608 government equipment. During FY 1968, 30 new requests for GFP were reviewed and coordinated by the Equipment Control Board. These requests were coordinated with NASA and all equipment has been received by the requesting Boeing organizations. The control board also processed 24 GFP reallocations during the reporting period; and

f) Equipment Control Board—All procedures that define the operation and authority of the Equipment Control Board were reviewed and modernized. One of the objectives of this review was to assure more effective control and reaction time on reallocated equipment. A fast reaction task force was established to accomplish this objective. Controls were also initiated to follow up on reallocated equipment.

CONFIGURATION MANAGEMENT

Implementation of Program Directives 44 and 44A, to certify stages S-IC-1 and -2 and their associated GSE prior to launch, was accomplished during the year. Certification of the S-IC and its GSE, as directed by Program Directive 44A, was underway at the end of the fiscal year for a more thorough description of activities required by Program Directives 44 and 44A, see page 66.

Implementation of the requirements of Change Order MICH-633 (Master Installation Notice Card Implementation Program) has been accomplished. This requirement was a prerequisite to proper implementation of that portion of MSFC/KSC Program Directive 44A that pertains to our certification of the MSFC "Saturn V Configuration Index and Modification Status Report" prior to launch of any stage. MICH-770, which has the same intent as MICH-633, has superseded MICH-633. Implementation of MICH-770 had been completed.

During FY 1968, limited Product Revision Records (PRR's) were implemented to correct minor engineering deficiencies on delivered but uninstalled retrofit kits. Strict control over the release of these PRR's is maintained by the configuration accounting office.

TECHNICAL PROGRAM ANALYSIS AND REVIEW

In February 1968 the new office of Technical Program Analysis and Review was established under the S-IC Program Executive. The purpose of this office is to analyze current management and operational control systems and interfaces with the goal of significantly increasing the effectiveness and efficiency of their performance in supporting program management decision processes.

During FY 1968, two task force efforts were conducted by this new office with the aim of improving the effectiveness and efficiency of stage transfer and delivery, and paperwork circulation at Michoud. The following results were achieved with an estimated net cost reduction of more than $10,000 per stage:

a) To level office labor peaks that occur at stage transfer and delivery, three steps were taken:

    1) Changes were initiated against the mechanized as-built data system to minimize effort required to resolve configuration exceptions;

    2) A team composed of representatives from the Boeing/Michoud Quality and Reliability Assurance, Operations, and Systems Test organizations was established for the purpose of resolving configuration exceptions via a procedure that eliminates duplicate effort and shortens flow time; and

    3) A factory area was set up to perform intermediate staging of "J" (flight) config-

MICHOUD CENTRAL SAFETY BOARD

During FY 1968 the NASA Emergency Evacuation Plan, M-1-29, was published and the Michoud Central Safety Board Chairman, directed each Michoud contractor's Health and Safety office to survey their areas for compliance with this plan. As a result of the Boeing survey, thirteen specific recommendations were made, primarily in the Building 102 south mezzanine area, to improve the location and condition of exit signs in the factory.

A comprehensive survey was taken of those areas utilizing Pyr-A-Larm fire and smoke detectors which contain small amounts of radioactive material. All such detectors were identified and registered with the Louisiana Board of Nuclear Energy.

MICHOUD LINE CONTROL SAFETY COUNCIL

The Line Control Safety Council continued its activities in safety awareness and accident prevention programs. During the reporting period, recognition for outstanding safety participation was given each month to an individual employee who was chosen by the Council. Additionally, a letter of commendation was written each month to the organization manager of the Safety Director who was most effective in promotion accident prevention.

LINE CONTROL SAFETY PROGRAM SUPPORT

The Michoud Safety Training Program gained impetus by the addition of a Safety Indoctrination Course series. This six course series covers safety command media, accident causes and prevention, and specific job hazards. All maintenance and manufacturing employees have attended each course in the series. The Line Control Safety supervisor and the Line Control Safety monitor training courses were updated during the fiscal year and presented monthly. Michoud new hire safety orientation includes instruction on industrial hazards, Company policy, and command media. Participation in the Line Control program is continually monitored. The "Line Control Program - Supervisor's/ Safety Guide" has been revised and distributed to all supervisors in the Line Control Program.

SAFETY ADMINISTRATION

There were 1262 reported injuries in FY 1968 compared to 1625 reported injuries in FY 1967. Health and Safety processed 97 Workmen's Compensation claims in FY 1968, 8 of which were disabling injuries. This compares to 127 claims in FY 1967, 10 of which were disabling injuries. The monthly frequency and severity rates of disabling injuries per million manhours worked are represented in Figure 1-2.

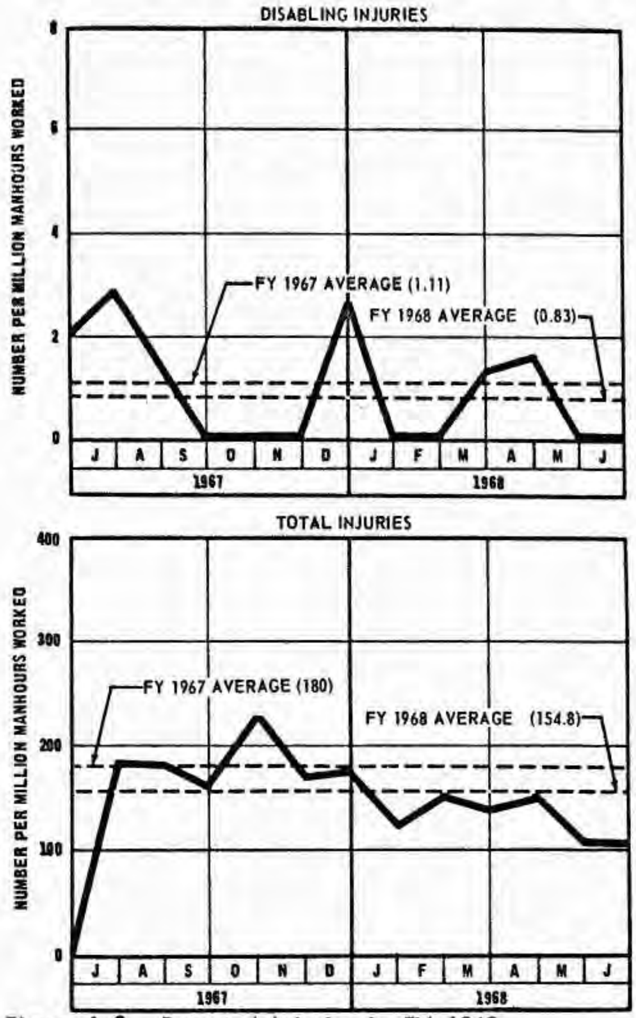


Figure 1-2 Reported Injuries in FY 1968

The statistical injury indices for FY 1968 are compared to FY 1967 rates in the following table:

	FY 1968	FY 1967
Reported total injury frequency average rate	0.83	180
Disabling injury frequency rate	0.98	1.11
Disabling injury severity rate	20.24	18.2
Workmen's Compensation claim rate	11.9	14.0

*All rates are per million manhours worked.

A program for improving the evaluation of employees for high risk, high value jobs has been proposed. This program involved revising the existing certification program and providing additional supervisor training and guidance. In addition, a new combined certification and health examination program will be administered to provide a standard health examination to all employees engaged in critical tasks.

INDUSTRIAL HYGIENE AND RADIATION SAFETY

Industrial hygiene activities during FY 1968 consisted primarily of evaluation and control of environmental health hazards resulting from industrial operations. Specific accomplishments during the past year include the following:

a) Improved exhaust ventilation was obtained to reduce the exposure to toxic and irritating vapors in the silk screen room and the potting and molding facility;

b) A central dust collection system was obtained for the tool grinding shop, and all equipment in the shop was provided with local exhaust ventilation;

c) All changes to process specifications were reviewed to determine that adequate instructions were included concerning safety handling of hazardous materials; and

d) Noise surveys were performed in several areas of the Michoud Assembly Facility, including the carbon arc gouging operation in the manufacturing development laboratory.

A summary of FY 1968 radiation exposure levels for several groups of radiation workers is given below:

Number of radiation workers on program	34
Average exposure to all radiation workers (millirem)	25
Average exposure to all quality radiographers (millirem)	33
Average of health and safety monitors (millirem)	53

The maximum allowable dose of radiation, as stated in Louisiana Radiation Regulations, is 5000 millirem per year. The employees on the radiation control program are engaged in welds-x-raying, laboratory work, radiation monitoring, and instrument calibration.

TECHNOLOGY AND AUDIT

A Health and Safety technology audit function has been formed. This function includes industrial hygiene, radiation safety, safety audits, and special projects.

The safety audit program schedule was accelerated to achieve the goal of performing an audit of each shop area every six months. Audit emphasis has shifted from detailed area safety inspections to evaluation of the Line Control Safety Program, and the effectiveness of each organization's hazard identification and control measures.

PARTICIPATION IN LOCAL INDUSTRIAL HYGIENE AND SAFETY EFFORTS

Active support of industrial hygiene activities in New Orleans colleges, universities, and professional societies has continued.

During the reporting period, several lectures were presented to classes at Delgado College and Tulane University, and a class of graduate students in environmental health from Tulane were given a lecture and a tour of the Michoud Assembly Facility.

The New Orleans office of Civil Defense presented a ten-hour Civil Defense Radiological Monitoring Course to selected Michoud personnel. Seventeen Boeing employees completed the course.

SAFETY ENGINEERING

Emphasis on hazard analysis and safety design review has been maintained in the areas of manufacturing process changes, test systems, tooling acquisitions, and facility modifications. Functions requiring special attention in the planning of safeguards were the oxygen flow tests, titanium machining, fuel tank hydrostatic test cycling, ablative coating, helium bottle changeout, "POGO" test program, hardware or stage transportation, and steel handling ring installation.

SAFETY SURVEILLANCE

Engineering surveillance and inspection activities have been expanded to provide direct technical support to the shop safety organizations. Professional safety personnel have been assigned to each shop area to assist in the identification of shop production problems. This method has proven to be effective.

MISSISSIPPI TEST FACILITY HEALTH AND SAFETY

Boeing/Mississippi Test Facility completed FY 1968 without a disabling injury. A total of 884,399 manhours were recorded during this period. Boeing/MTF has worked 2,061,972 manhours and recorded only one such injury. That injury occurred in May, 1966. Since that date 1,899,617 manhours have been worked without a disabling injury. The monthly rate of injuries per million manhours worked at MTF are presented in Figure 1-3.

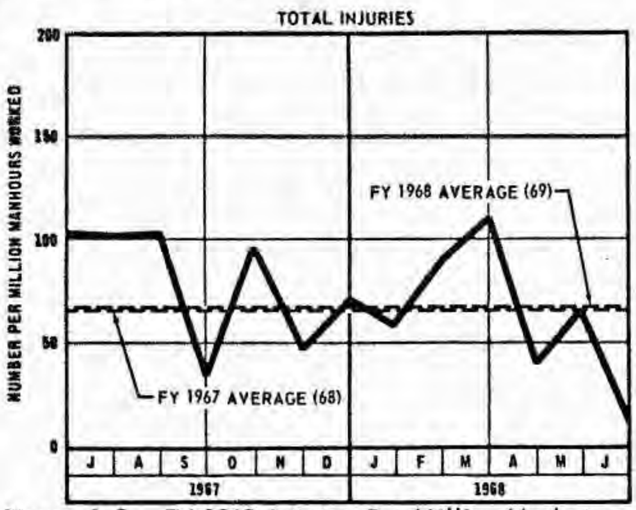


Figure 1-3 FY 1968 Injuries Per Million Manhours - MTF

Several studies have been made to improve fire protection capability on the S-IC Test Stand. These studies have resulted in a proposal that, when implemented, will provide auxiliary fire protection capability when the high-pressure industrial water system is out of service.

In August 1967 the Michoud Safety Contest was expanded to include Boeing activities at MTF. Out of a possible 100 points, the MTF's point standing rose from 63.1 to 98.7 by the end of CY 1967. At the end of the fiscal year, Boeing/MTF's point standing is third with a cumulative standing of 600.5.

An MTF quarterly Safety Award Program was established in April 1968. This award is presented to the employee who has demonstrated outstanding safe-work attitudes, influenced the safe-work attitude of fellow employees, taken initiative to locate, identify, and report safety hazards, and measurably contributed to the Safety Program.

SECURITY

Proper security of all classified data, material, and hardware was maintained during FY 1968. Security inspections of the Boeing portions of the Michoud Assembly Facility were conducted in September 1967 and January and May 1968. Each of these inspections indicated that our security procedures and Industrial Security Manual compliance are satisfactory.

Representatives of Factory Mutual Insurance and Factory Insurance Association conducted recurring loss prevention inspections on a quarterly basis during 1968. These inspections revealed that Boeing fire prevention procedures were satisfactory.

A security education program was given to 180 members of management by the Boeing Corporate Director of Security on March 25, 1968. Security clearances were granted to 459 employees during FY 1968.

Evacuation control plans were developed for Boeing occupied areas in the S-IC test complex, S-IC booster storage building, and Engineering and Administration Buildings at MTF. Evacuation routes were posted in all work areas of these facilities, and detailed instructions were distributed to all personnel. Fire and evacuation drills have been conducted and assessed by management in each facility. Fire brigades were formed and trained for each facility consisting of four teams in the S-IC static test stand and one team in each of the other facilities.

The Hurricane Preparation Committee conducted a comprehensive review of our existing "Hurricane and Tropical Storm Plan," and although the content of the plan required no changes, there were sufficient organization, location, and title changes necessary to require its reprinting.

The "Boeing/Michoud Plant Disaster Plan," which is a comprehensive disaster control plan, has been updated and released. It contains detailed planning for the protection of personnel and plant during natural disasters, major accidents, and civil disturbances, also a civil defense and evacuation plan.

PERSONNEL

MANPOWER

Michoud and the Mississippi Test Facility employment declined by 833 employees during FY 1968. This planned reduction was made possible by increasing efficiency, schedule changes, and the continuing transition from a developmental to a production type program. The following comparison indicates the reduction in each payroll.

Payroll	6-29-67	6-27-68	Net Change
		Total Michoud and MTF	
Hourly	1,607	1125	-482
General Office	2,023	1767	-256
Professional/Technical	850	769	- 81
Supervisory	508	490	- 18
Office Exempt	99	103	+ 4
Total	5,087	4254	-833

Of the Michoud and MTF total of 4254 as of June 27, 1968, 3394 employees were new hires and 860 were transfers from other Boeing locations.

TRAINING

Paid-time training increased during FY 1968 with 14,677 employees completing 1474 classes. In FY 1967, 8182 completed paid-time training classes.

Of the 14,677 employees who received paid-time training during FY 1968, 1641 completed 296 certification classes; 1808 completed 512 re-certification classes; and 11,228 completed 666 systems, skills and management courses.

MTF training requirements have been supported on a continuing basis. Major emphasis has been placed on certification, re-certification, reliability, and safety training programs in support of critical operations for S-IC stage testing.

A steadily declining work force caused a reduction in the number of employees participating in off-hour training programs. During FY 1968, 640 employees completed 55 courses. During FY 1967, 883 employees completed 82 courses.

Attendance at seminars, technical sessions, and symposiums increased during FY 1968 with 610 employees in attendance. During FY 1967, 341 attended similar sessions.

MANAGEMENT DEVELOPMENT PROGRAM

The Management Development Program has been significantly expanded and strengthened during FY 1968. A separate management development function has been established as a part of the Industrial Relations organization. This function is responsible for the administration of activities leading to early identification, selection, and development of the management talent needed to meet current and future needs.

Michoud is represented on the Boeing Launch Systems Branch Management Development Committee which is responsible for the formulation of objectives and plans that will ensure effective management development actions. It also identifies improvements, reviews progress, and provides recommendations pertaining to Launch Systems Branch management development activities.

Three off-hour management courses were attended by Boeing employees; and 12 paid-time management courses were conducted for 680 employees.

GRADUATE STUDY PROGRAM

As a result of the Boeing Graduate Study Program, 11 employees will receive their Masters degree at the end of the Summer term in 1968. Additionally, 75 employees took 361 credit hours during the Fall semester 1967, and 55 enrolled for 271 credit hours for the Spring semester of 1968.

UNDERGRADUATE PROGRAM

As a result of the Boeing Undergraduate Study Program that was implemented in FY 1967, four employees will receive their Bachelors degree at the end of the Summer term in 1968. Additionally, 54 employees took 299 credit hours during the Fall semester, 1967 and 37 enrolled for 182 credit hours for the Spring semester of 1968.

COOPERATIVE WORK-STUDY PROGRAM

The Michoud Cooperative Work-Study Program has increased from 28 students in FY 1967 to 50 students in FY 1968. This represents the largest number of Co-op students of any location or Division in the Company. Forty-four are Engineering students, five are Math and Computer Science students, and one is a Management student.

PLANS FOR PROGRESS AND EQUAL EMPLOYMENT OPPORTUNITY PROGRAMS

A special team of investigators from the Contracts Compliance Office of the Department of Defense conducted a formal investigation of the Michoud Assembly Facility in August, 1967. Fourteen recommendations concerning certain personnel practices and procedures resulted from this audit. Subsequent Boeing action taken on each of these recommendations has been acceptable to the Contracts Compliance Office.

An Equal Employment Opportunity Administration function was established in October, 1967. This function includes the development, maintenance, and monitoring of affirmative action policies and procedures for all aspects of the Boeing/Michoud Equal Employment Opportunity Program.

A Boeing/Michoud Equal Employment Opportunity

Committee was established in January, 1968. It concerns itself with all activities related to Equal Employment Opportunity within the Boeing/Michoud complex and assists in the promotion of equal employment opportunity regardless of race, religion, color, sex, age or national origin.

During the reporting period, a member of Boeing Management was elected Vice-President of the New Orleans Voluntary Equal Employment Opportunity Council. Boeing Management was also represented on the boards of the following organizations: (1) New Orleans Social Welfare Planning Council - the planning arm of the United Fund; (2) The Community Relations Council - a biracial group affiliated with State and National Community Relations Council Organizations; (3) The City Department of Public Welfare; (4) The Citizens Advisory Committee to the Southwest Educational Development Laboratory - a committee organized to resolve problems on intercultural education related to Negro and Southern American minorities; (5) The Urban League of New Orleans; (6) New Orleans Area Manpower Advisory Committee - a committee that has approval authority for the funding of all training in a seven parish sector falling within the provisions of the Manpower Development Training Act of 1962; and (7) Personnel Advisory Committee of Total Community Action - the committee devoted their efforts toward ensuring the success of the Concentrated Employment Program (CEP).

All non-supervisory Boeing employees were briefed on the Company's Equal Employment Opportunity policy. Supervisors and prospective candidates for supervision who attended the Introduction to Management course received comprehensive EEO briefings.

The Fall and Spring College Relations Program resulted in recruiting teams visiting 21 colleges, seven of which were predominantly Negro. Industrial Relations hosted 30 Job Development Specialists and Center Directors from the 15 Systematic Training and Redevelopment (STAR) Incorporated Basic Education Centers located in Mississippi. A briefing and tour of the facilities were included in the visit.

Two Negro students from Southern University, Baton Rouge, Louisiana, participated in the 1967 Co-op Program. A former Negro Co-op student of the University of Detroit accepted an offer of permanent employment.

Seven Negro employees (five supervisors and two non-supervisors) completed the recently developed Introduction to Management course for supervisors and prospective candidates for supervision. One of the non-supervisors was later promoted to supervisory status.

During this reporting period, three Negro employees were promoted to supervisory status raising the number of Negro supervisors to six.

COMPUTER SCIENCES

During FY 1968 the Business Information and Support Services, and Command Media Organizations were transferred from the Information Management Organization to the Program Planning and Reporting Organization. The remaining Information Management Organization was then redesignated Computer Sciences Applications (CSA). This organization was deemed necessary to permit CSA to effectively support the conversion to third generation computer systems. During the organizational realignment, a Computer Systems Requirements Organization was created within CSA to act as liaison between using organizations and systems design groups. This organization exercises surveillance over all mechanized data systems from request to implementation, and assures maximum system efficiency and integration.

MECHANIZED DATA SYSTEMS DEVELOPMENT

NEW SYSTEMS IMPLEMENTED

As-Built Configuration System—The Michoud As-Built Configuration Management System was successfully implemented with the delivery of the S-IC-4 in March 1968. Many of the reports previously prepared manually for the Acceptance Data Package are now obtained automatically from the mechanized system.

The mechanized system examines a specified Engineering design baseline and then expresses the as-built configuration of a given S-IC stage as equal to the design baseline, plus or minus some known level of exceptions. This provides Boeing Quality and Reliability Assurance with overall configuration management in support of deliveries, as well as data for launch readiness reviews.

The as-built system uses the exception principal for recording configuration data. This allows the system to rapidly recognize and/or resolve differences in configuration due to engineering design changes. The system also tracks instrumentation components, traceable parts, time-cycle and age life sensitive parts, retrofit installations, and configuration exceptions.

The as-built system:

a) Eliminates the need for manual comparisons between two engineering design baselines;

b) Provides a concise listing of configuration exceptions in an indentured sequence, thereby providing a display of the systems which are in a "no-go" condition due to a configuration deficiency;

c) Produces summary listings and reports on a timely basis for management visibility; and

d) Allows for rapid accountability of as-built configuration differences between any two S-IC vehicles.

The scope of the As-Built System is currently being expanded to serve the needs of MTF and the Boeing Atlantic Test Center (BATC). This will provide a common configuration accountability system for each S-IC from manufacturing through flight.

MTF Recap System—The MTF Recap System, a set of computer programs designed to track Saturn record system paperwork by maintaining a visual listing of open items against stage processing and GSE configuration changes at MTF, has been implemented. This system is directed toward obtaining zero defects testing by providing the necessary visibility for organizing scheduled work, tracking open work, and documenting completed work.

Operations Change Status Reporting—The Operations Change Status Reporting System was implemented during FY 1968. This system's objective is to schedule and monitor a committed change to the basic contract from the time the change is committed by the change board to the date of delivery. Reports from this system provide operations management with current detailed status visibility on committed change; a detailed change scheduling tool; and a means to measure performance on committed changes.

Some of the other mechanized data systems developed during the past year, and a brief description of each, are:

a) Equipment and Final Assembly Part Shortage System - provides management with better visibility on parts shortages existing in equipment and final assembly parts crib areas;

b) Packaging Preservation Requirements System - maintains a reference file of packing and crating specifications for all parts shipped from Michoud; and

c) Facilities Stores Inventory System - maintains inventory control of spare parts and consumable supplies stocked for use in the Factory Equipment Maintenance Program.

SIGNIFICANT SYSTEMS MODIFICATIONS

PERT—Visual Task Analysis (VISTA), a computer program designed to automatically plot PERT networks on the SC-4020 Digital Plotter, has been implemented. The automation of plotting networks will replace the manual drafting efforts required to update PERTed networks while permitting a one-to-one accuracy correlation of network graphics to PERT tabular reports.

Cost Review System—Major modifications were made to the Launch Systems Branch Cost Review System which collects and updates actual labor cost data by task and NASA 533 report line number. These changes increased the capabilities of the system to produce automated graphical displays and management and customer reports of actual and budget data at the task, contract-schedule, organization, and manager levels.

CONVERSION TO THIRD GENERATION EQUIPMENT

We are continuing the conversion of Honeywell computer equipment programs to run on the Univac 1108 computer. The following systems are now being processed on the Univac 1108: Part Requirements, Material Inventory Control, Facilities Equipment Acquisition, Plant Services Maintenance, Southeast Personnel Accounting and Records, Suggestion Records, Filling of Hourly Openings, Stage Cost Control, As-Built Configuration, Engineering Release, Traffic Routing, and Facilities Stores Inventory. As part of the conversion redesign, significant compression of programs is being accomplished, leading to reduction in computer run-time and operational set-up time.

COMPATIBLE CONVERSION SYSTEM

The requirement that Boeing convert its programming to operate on a Univac 1108 computer with direct access mass storage has led to the concept of a centralized file management system as the most economical and efficient approach to conversion. The file management system must perform record address lockup, data retrieval, data restructuring, file backup, and access control. Additionally, the system must support operations under both Univac 1108 Executive Systems--EXEC II and EXEC VIII. The Compatible Conversion System satisfies these requirements. Also, operating as a set of library subroutines available to both Fortran and Cobol worker programs, it supports the following features:

a) Automatic index construction and maintenance for user-specified data files;

b) Data storage, retrieval, and updating commands for direct record access;

c) Automatic record blocking and deblocking to increase serial processing speed;

d) Standard file backup and recovery procedures; and

e) Logical file structuring facilities.

The Compatible Conversion System will operate under either Univac EXEC II or EXEC VIII, allowing conversion of worker programs to a stable mass storage interface. The system has been designed and coded and is currently being checked out against both Executives.

NUMERICAL CONTROL

A year ago, the use of Numerical Control (NC) machinery at Boeing/Michoud was just beginning. Only the Cincinnati ATC-430 machine was in production. No software was available for this machine; hence, all part programming was manual, difficult, and tedious. Since that time the N/C computing group has modified, implemented, and checked out software (postprocessors) for six N/C machine tools. They are the Cincinnati ATC-430, Sunstrand N/C-3 Milling Machine, Gorton 2-30 Tape Master, Sunstrand OM-3 Machining Center, Kearney and Trecker Skin Milling Machine, and Cincinnati Veroi-Power N/C Bed Mill. The first three machines are in production status. The other three are scheduled to go in production by the summer of 1968. All software packages have been checked out and are awaiting machine activation.

FLIGHT DATA EVALUATION

A system of computer programs developed during 1967 and 1968 to support S-IC flight evaluation was used to process data from S-IC-1 and -2 flights. Some of the outputs of this system, e.g., tapes containing re-formatted, calibrated data, are contractually required deliverable data, with a very rigid schedule. Half of the data items for S-IC-1 were delivered on schedule and half were behind schedule for various reasons, including late receipt of input data, unexpected data anomalies, and processing problems. All deliverable data items for S-IC-2 were delivered on or before schedule even though some input data items were received late. The outputs of the system required to support Boeing's presentations to the Flight Evaluation Working Group were available when needed.

MECHANIZED DATA PROCESSING

CONVERSION TO UNIVAC 1005

The Univac 1004 Card Processor was upgraded to a Univac 1005 Card Processor. This equipment modification allows usage of internally stored program instructions to execute production processes. Before the equipment was modified, machine instructions had to be wired into a logic panel. This is a time-consuming process. The programming effort required to put a job into production has been significantly reduced by the equipment modification.

OPTICAL SCANNER UTILIZATION

Usage of the Control Data Corporation 915 Optical Scanner has been significantly increased during FY 1968. Current output volume of cards is approximately 25,000 per month. Applications under development are expected to boost this figure to 100,000 records per month by mid-year.

MECHANIZED DATA SYSTEMS STANDARDS

Technical standards to direct and control the development and implementation of automated systems have been written and released. Documentation standards for defining automated system requirements, system design, and maintaining computer program system configuration control are now in force. Documentation standards governing the acceptance test, the user's guide, and the program maintenance guide will be released in the near future. In addition, approximately 120 technical standards have been issued to CSA programming personnel describing the equipment available for use in automated systems (both second generation and third generation), characteristics of the software on these systems, and guides to efficient use of this computer hardware/software.

During the next year it is expected that the initial development of technical standards will be completed. These standards will cover all areas of technical information needed to interface with the Slidell Computer Operations Office contractor, guides to good programming practice, documentation standards, design standards, and programming language and equipment standards. These standards are expected to contribute to improved design of computer programs and to their usefulness to others by virtue of program generality and comprehensive program documentation.

BUSINESS INFORMATION SERVICES

COMMUNICATIONS

During FY 1968 the number of listings in the Michoud telephone directory and the number of volumes published were reduced. On March 20th, the alphabetical section for Boeing was reduced from 5300 name listings to 1735. The number of pages for the Boeing section was reduced from 67 pages to a total of 22 pages. The total number of directories received from the Support Contractor was reduced from 5000 books per quarter to 3000 copies. This resulted in an estimated cost savings of $16,840 per year.

On March 14, 1968, NASA restored indicia mail privileges to Boeing official mail destined for Washington, D.C., Huntsville, Alabama, and Cape Kennedy, Florida. This privilege will result in estimated postage savings to the government of approximately $24,000 per year.

During FY 1968 a Michoud directive was revised and published to establish telephone standards patterned after the Boeing Aerospace Group Administrative Services Business Manual. As a result, since October 31, 1967, Michoud telephone equipment costs have been reduced by $2563 per month. This reduction represents $30,756 per year savings to the Government.

RECORDS MANAGEMENT

During FY 1968, approximately 2500 cubic feet of records were received from Michoud organizations and stored in the records storage center. Based on Boeing Aerospace Group records and release cost standards, a savings of $2.65 per cubic foot of records is realized when records are placed in inactive status in storage areas as opposed to office areas. In FY 1968, using this standard, a net savings in the amount of $6651.50 was realized.

A mechanized system, which provides a listing of organization working files, has been developed. This system provides a master listing of records, with common Michoud categories and subcategories, including specific types of records, file location, and responsible supervisors. The purpose of the system is to provide rapid identification, location, and retrieval of records associated with cost, schedule, and product technical performance.

The Classified Control Station has completed another full year of service to the various Michoud organizations without a single security violation.

COMMAND MEDIA

The Boeing Launch Systems Boeing/Michoud Command Media System formally establishes and documents management policies and controls, authority delegations, and practices. During FY 1968, the command media documentation of systems and product control was revised to ensure meeting NASA and Boeing goals. The record system for the S-IC stage was more clearly established with the issue of eighteen new and revised procedures. A new system has been devised to ensure timely response, traceability, and economy for contractual data delivery requirements and is proposed for implementation through appropriate command media. The documentation of the Saturn V interschedule working relationships between Schedules I, II, and III to command media is now in progress. Management Directives and Operating Procedures are forwarded to NASA, on a quarterly basis, as contractual data delivery requirements.

DOCUMENT CONTROL

The Boeing Launch Systems Branch Document Control System, since its implementation, has proven to be one of the most cost effective operations at Michoud. During this reporting period, additional significant reportable savings have been generated and validated through the cost improvement system. Identified savings, associated with the cancellation of documents during preparation (that were considered valid by both Boeing and NASA/MSFC), were undetermined by NASA Headquarters at the close of FY 1967. The validity of these savings was established during FY 1968 when $480,590 in savings for these activities were approved for the Launch Systems Branch. The total validated contribution of the Document Control System to the Cost Improvement program through CY 1967 exceeded $13 million, which was 13.57 percent of Michoud and 9.64 percent of the total Boeing Launch Systems Branch savings.

Document Control participated in NASA/Boeing negotiations for the revision of contract deliverable data requirements directed toward consolidating Contract NAS8-5608, Schedules I and IA, Data Requirements Lists (DRL), developed a data management statement of work, and clearly identified, through line items in the DRL, total data delivery requirements for both contract schedules. Text proposed by Document Control to improve contract data Management was successfully negotiated into the statement of work. The consolidated DRL and statement of work were implemented by Contract Document IN-I-S-IC-67-10, S-IC Program Deliverable Data, in January 1968.

To fulfill a need to improve contract data delivery management, Document Control participated with Michoud Contracts in developing a new system for the production release, accountability, and delivery of data. The new system eliminates multiple channels for delivering data to NASA and replaces them with a more orderly and cost-effective flow through existing centralized release services. It also establishes a data serial numbering system, consistent with contract requirements, which permits management accountability and traceability of deliverable data.

In March 1968, Document Control issued instructions that changed the focal point for issuing Boeing document serial numbers and implemented a new format for requesting document development authorization. These changes simplified the maintenance of the "LSB Document Control Report" by eliminating previously required monthly organizational data inputs.

Consolidation of the document number issuance with the preparation of data inputs into one functional area under Document Control has reduced workloads of all organizations. It has also ensured the timeliness and accuracy of document indices.

A review of document activity during the reporting period (see Figure 1-4) indicates an increase in the number of active documents during the last year. A substantial portion of this increase is the result of incorporating into the system, documentation that was not formerly included, and for which accountability or distribution control did not exist.

FORMS MANAGEMENT

During FY 1968, the LSB Business Forms Management System has continued to be a cost effective operation. Under this system there has been no out-of-stock situation in Forms Store during the past year. Also, by careful inventory, issue and reorder control, reproduction requirements imposed on the support services contractor for business forms has been decreased by 40 percent while the number of controlled form items has increased 35 percent over the preceding year.

GOVERNMENT FURNISHED SUPPORT SERVICES

At the request of NASA, Boeing conducted a study of its support services requirements to reduce the overall support effort by 25 percent. The FY 1968 negotiated budget for government furnished support services (less Computer Services) for Boeing/Michoud was $6,973,000 compared to $8,350,000 for FY 1967. The reduction in projected support services was about 16 percent. Actual expenditures, if extended through June 1968 at the present rate, will amount to $6,458,600, an additional support services reduction of about 7.3 percent. Therefore, the government furnished support services required during FY 1968 were decreased by 23 percent, or $1,891,000 from the FY 1967 level.

As a result of improved communications and coordination between Boeing Reproduction and the support services contractor's reproduction representatives, more Boeing reproduction requirements are being accomplished in a timely manner by the support services contractor. This has enabled us to reduce headcount in the Boeing reproduction shop by approximately 30 percent.

MICHOUD ORGANIZATIONS REALIGNMENTS

During FY 1968, several significant changes were made in the Boeing/Michoud organization structure.

To provide a consolidation of related functions and posture during the first quarter, the Information Management organization concentrated its resources on the task of implementing the new computing equipment at the Slidell Computer Center. Business information and support services and the command media functions were transferred from Information Management to the Program Planning and Reporting organization.

In the second quarter, the Michoud Information Management organization was redesignated Michoud Computer Sciences Applications, which

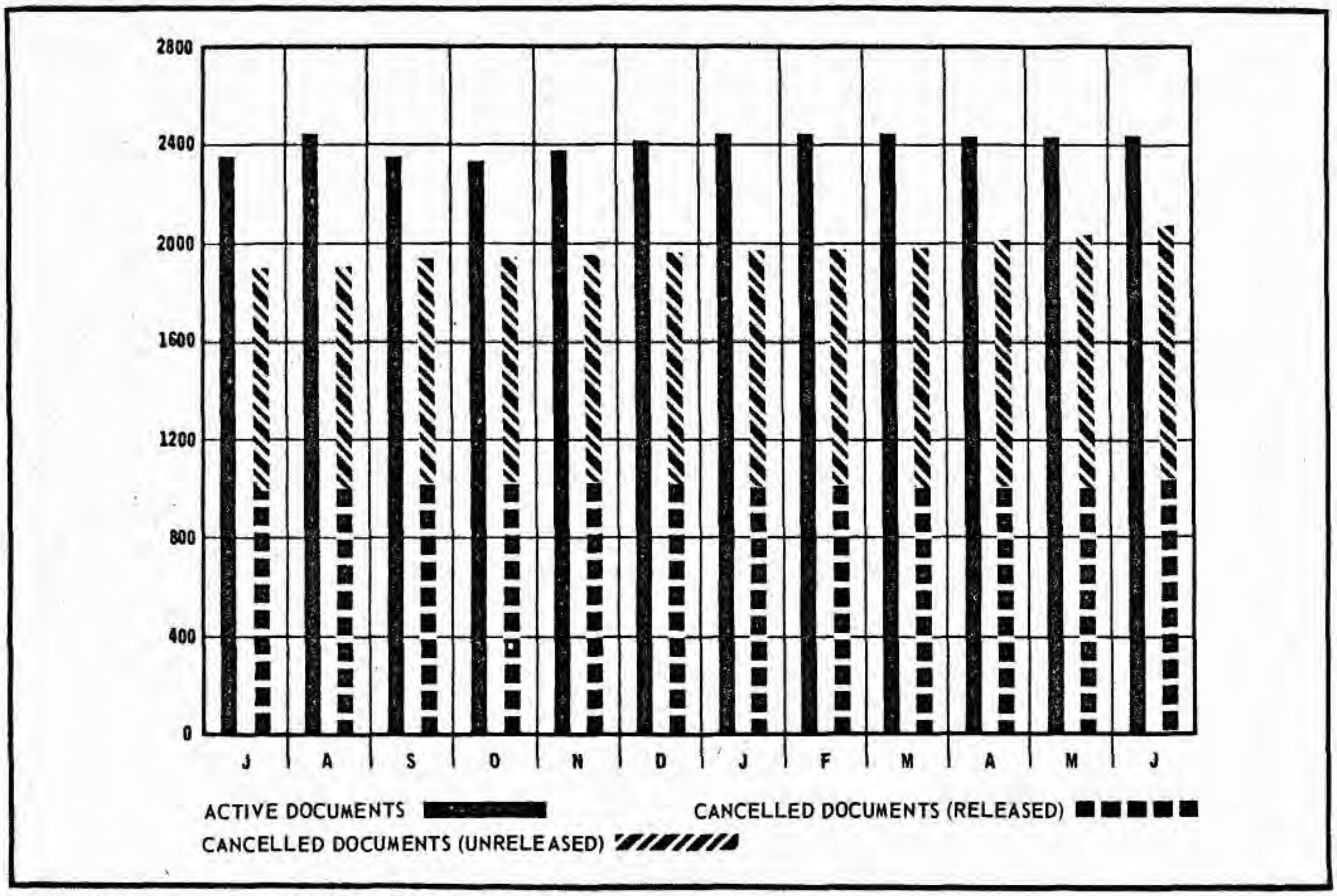


Figure 1-4 Document Activity During FY 1968

properly denotes the functional description of the organization.

At the beginning of the third quarter, the S-IC Program test function emphasis shifted from static firing to flight, thus the test evaluation function was transferred from the Systems Test organization to the Engineering organization. This change enables the test evaluation involvement in flight evaluation tasks to be accomplished more efficiently.

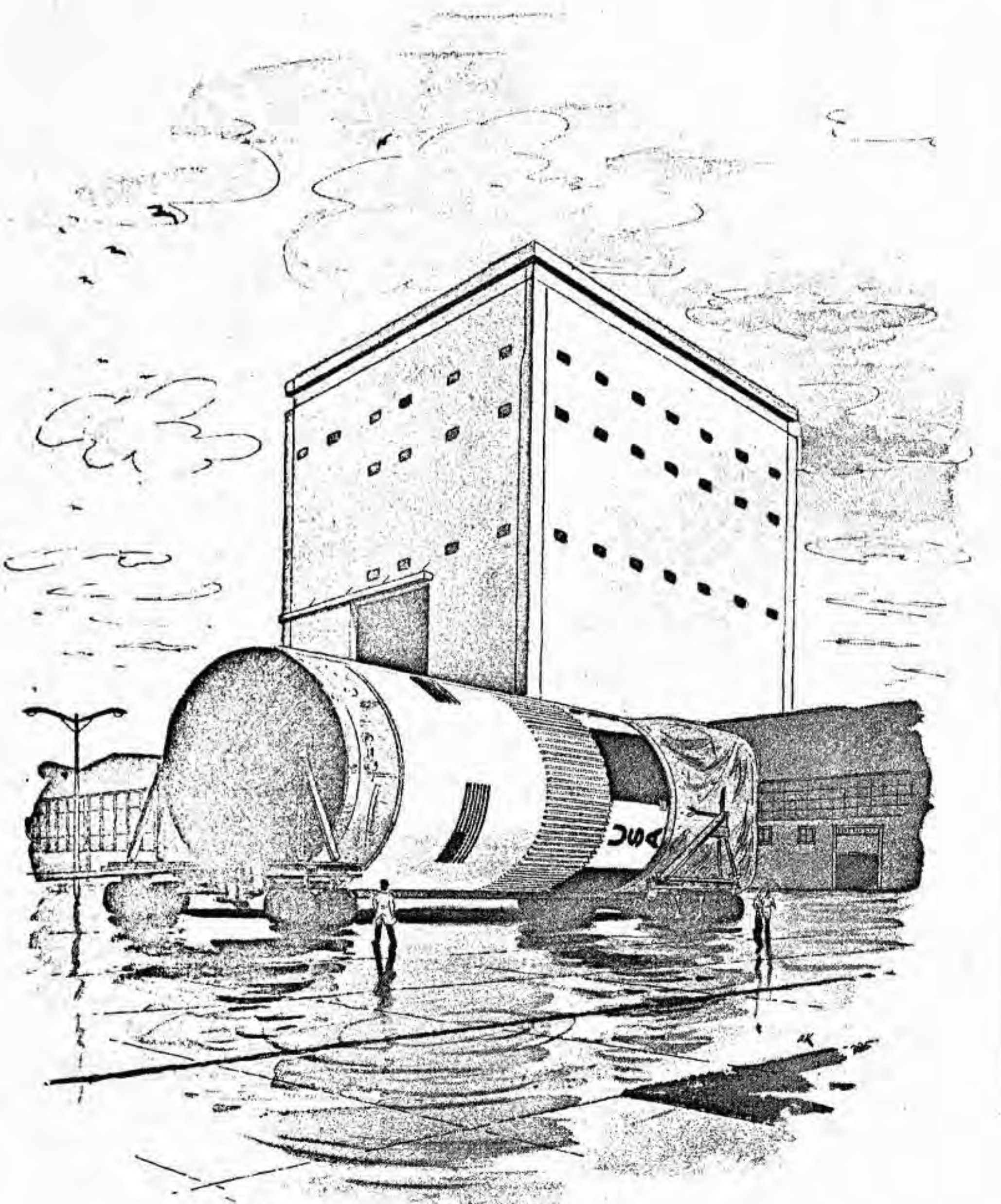
The S-IC Operations organization was realigned in the third quarter of the reporting period. This realignment involved combining all Industrial Engineering organization to more effectively utilize skills while maintaining proper support to the manufacturing organization; and consolidating all manufacturing activities and manufacturing support activities to effectively reduce operating costs without impacting performance schedules.

The S-IC Systems Test Manager's office was relocated from Michoud to MTF in the third quarter of the fiscal year to enable Boeing to establish a closer working relationship with the NASA Manager at MTF.

The Management Development Coordinator position was established during the fourth quarter of the fiscal year, reporting to the Michoud Industrial Relations Manager, because of increased emphasis on management development and because of recommendations set forth in the Launch Systems Branch Management Development Plan.

CONTRACT END ITEMS & SERVICES

2



SUMMARY

Launch of the AS-501 and -502 took place at the Kennedy Space Flight Center (KSC) during FY 1968. These vehicles were thrust into flight by the S-IC-1 and -2. Both stages, and their Boeing supplied ground support equipment, functioned satisfactorily and no anomalies or objective discrepancies occurred which adversely affected their flight.

The first Boeing/Michoud manufactured flight stage, the S-IC-3, was shipped to KSC on December 23, 1967. This stage is now at KSC where it is being modified in preparation for the first Manned Apollo Saturn Launch.

Several significant incentive milestones were achieved during FY 1968. The S-IC-4 was delivered to NASA, on-dock Michoud, on August 28, 1967. This stage has remained at Michoud since formal delivery, and is presently undergoing modifications which were originally scheduled for completion at KSC. Also during FY 1968 the S-IC-5 was successfully static fired, and S-IC-6 and -7 completed post-manufacturing checkout.

At the end of the reporting period the S-IC-8 and -9 had been completely assembled and were in storage awaiting start of post-manufacturing checkout. Also, the S-IC-10 was in horizontal assembly, and S-IC-11 through -15 major structures assembly was proceeding as scheduled.

Throughout the fiscal year S-IC stage and GSE design activities were directed toward increasing the quality of the product and resolving problems and anomalies identified. These efforts were supported by various testing programs including reliability, qualification, development, and failure analysis. During FY 1968 Engineering laboratories completed 331 tests. As a result of the POGO phenomenon experienced during the AS-502 flight Boeing has formed a task force to cope specifically with this problem to assure its alleviation prior to the next S-IC flight.

Quality and product assurance activities were conducted on a continuing basis during FY 1968. The objective of these activities is assurance of the quality of the end item and its components, and assurance that activities critical to missions or programs are identified, planned, and accomplished. During the reporting period 55 quality audits were conducted as a part of the quality program. These audits resulted in the definition of 467 discrepancies which have been resolved or are being resolved at this time.

The Quality Maintenance Program was initiated by Boeing during FY 1967 and expanded by Change Orders MICH-544 and MICH-723 during FY 1968. The purpose of this program is to assure the quality of vendor hardware, with primary emphasis on that hardware where failure could cause loss of stage or crew. This program includes Boeing Management visits to vendors, audits of engineering documentation, quality analysis of vendor hardware, and other testing and motivational techniques designed to improve the quality of vendor hardware.

DELIVERABLE HARDWARE

S-IC STAGES - NASA/MSFC ASSEMBLED

S-IC-1 AND S-IC-2

At the start of FY 1968, both the S-IC-1 and -2 were at KSC where they were undergoing preparation for launch. These vehicles were launched, as part of the AS-501 and -502 missions, on November 9, 1967 and April 4, 1968, respectively. (Figure 2-1 shows the AS-501 being moved from the KSC VAB, Figure 2-2 shows AS-501 launch.)

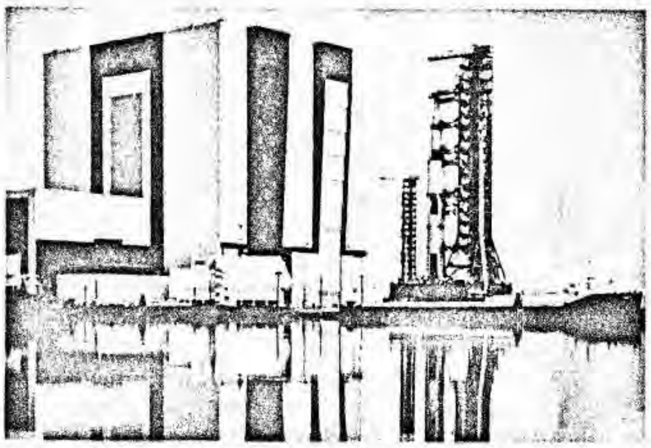


Figure 2-1 AS-501 Moving From KSC VAB

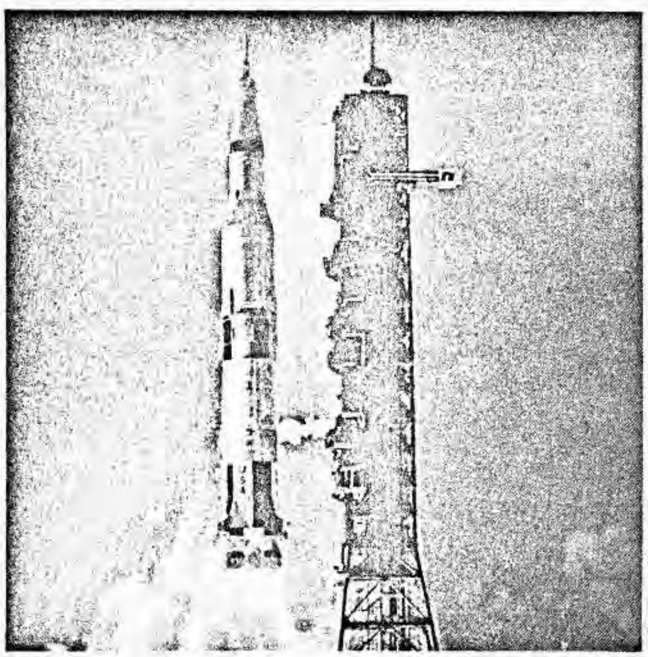


Figure 2-2 AS-501 Launch

Subsequent to the AS-501 and -502 launches, all available S-IC-1 and -2 performance data, including engineering sequential film and S-IC/S-II stage separation film from the S-II stage was evaluated by the Boeing Performance Analysis team.

The S-IC-1 and Boeing supplied GSE performed satisfactorily during AS-501 countdown and flight and, in general, all S-IC-1 mission objectives were met. Performance of all systems was satisfactory, and any anomalies or objective descrepancies which occurred did not adversely affect overall stage systems performance.

Performance of all S-IC-2 systems was satisfactory during countdown and launch of the AS-502. Performance of the Boeing supplied S-IC GSE was also satisfactory, and no failures of components or systems occurred during launch countdown. No failures or deviations which occurred in S-IC systems during the AS-502 launch adversely affected overall stage systems performance. The occurrence of the POGO phenomenon (see page 37) caused no problems on the S-IC-2.

Specific problems encountered during the AS-501 and -502 launches, and the corrective actions taken to rectify these problems, are discussed throughout Section II of this report. Detailed information on S-IC-1 and -2 performance during these flights can be obtained from Documents T5-7000-1, S-IC-1 Flight Report, released January 11, 1968 and T5-7000-2, S-IC-2 Flight Report, released June 28, 1968.

S-IC STAGES - BOEING ASSEMBLED

S-IC-D

The S-IC-D was stored in the S-IC booster storage building at MTF at the start of the fiscal year. On November 10, 1967, it was erected in the S-IC static test stand at MTF for a series of fuel tank drain tests, which commenced on December 18, 1967, and were completed on January 17, 1968. (See anti-vortex tests, page 75.) On February 1 the stage was removed from the test stand and on February 6 was again placed in storage in the booster storage building at MTF.

In early April 1968, the S-IC-D was placed aboard a barge and transferred to Michoud. It was then sent to MSFC on April 23, 1968, where MSFC plans to place it on display at the Space Orientation Center in Huntsville, Alabama.

S-IC-F

At the beginning of FY 1968, the S-1C-F, in storage at

Michoud, was being used for crew training in preparation for the S-IC-3 helium bottle changeouts authorized by ECP 0215. The stage remained in storage until March 8, 1968, when it was moved to the Michoud Vertical Assembly Building (VAB) where it was erected on March 12, 1968. While in the VAB, the aluminum forward handling ring was removed, and a steel handling ring was installed in its place. The stage was returned to storage on March 18, 1968, where it remained until May 20, 1968, when it was moved to the factory for removal of a LOX suction duct required to support the Michoud LOX Suction Duct Flow test fixture which has been constructed at Michoud to test dynamic characteristics of suction lines for the proposed POGO suppression system (see POGO, page 37). Figure 2-3 shows the LOX duct being removed, Figure 2-4 shows it installed in the test fixture. At the end of the report period, the S-IC-F was still in the Michoud factory building.

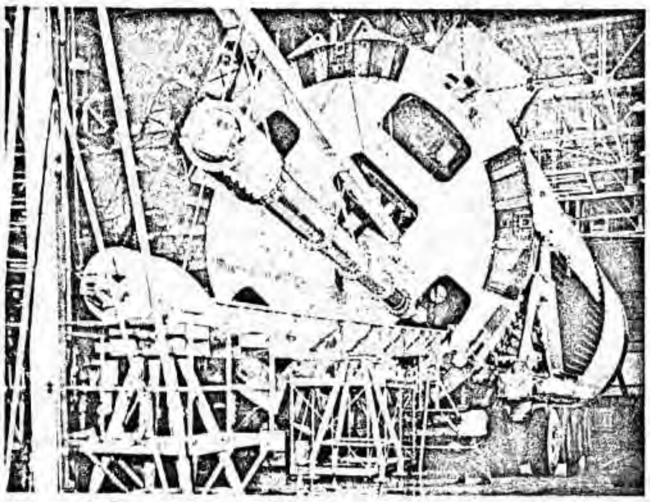


Figure 2-3 S-IC-F LOX Duct Removal

S-IC-3

The S-IC-3 was accepted by NASA (Michoud on-dock incentive milestone) on March 15, 1967. The stage was then placed in storage at Michoud where it was located at the start of the reporting period.

During the first half of FY 1968, eighty-one modifications were incorporated into the S-IC-3 at Michoud.

Formal retesting of the S-IC-3 prior to shipment to KSC began on November 13, 1967. Retesting was completed on December 5 and the S-IC-3 was accepted by NASA on December 11, 1967. The stage was then placed on a barge on December 21, departed Michoud on December 23, and arrived at KSC on December 27 where it was erected in the VAB on December 30, 1967.

Following launch of the AS-502, it was decided that the AS-503 would be a manned launch. For this reason the vehicle was de-erected, and the S-II stage was shipped back to MTF for a second static firing. At present, the S-IC-3 is undergoing extensive modification at KSC, with a tentative launch date in November 1968.

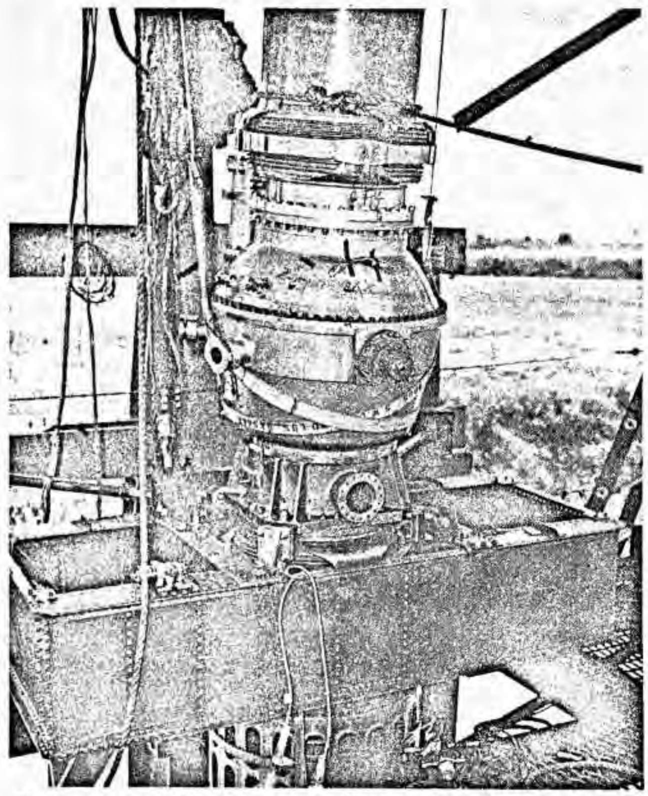


Figure 2-4 LOX Duct Installed in POGO Test Fixture

S-IC-4

The S-IC-4 was undergoing refurbishment and post-static checkout at the start of the reporting period. Post-static checkout was completed with customer acceptance of the simulated flight test on August 16, 1967. The stage was then placed in storage on August 22, 1967. It was accepted by NASA, on-dock Michoud on August 28, 1967 (3494.6 out of a possible 3498.6 incentive points were earned) and it remained in storage until December 27, 1967, when it was moved to the stage test facility for modification and retest. Retest was accepted by NASA on March 22, 1968, however shipment of the stage to KSC was deferred by NASA direction. On April 1, 1968, incorporation of all changes that could be "rolled back" from KSC began at Michoud. Modification is continuing, with shipment of the stage to KSC presently scheduled for August 23, 1968.

S-IC-5

The stage had just been loaded into the static test stand at MTF at the beginning of FY 1968. Pre-static firing checkout of the stage was completed, and on August 25, it was successfuly static fired for 125 seconds. Incentive points of 260.0 out of a possible 260.0 were earned for this firing. (For a detailed description of S-IC-5 static firing activities see page 73.)

The stage was removed from the static test stand on September 11, shipped back to Michoud on September 12, and moved (Figure 2-5 shows an S-IC stage being moved from the Michoud factory building) into the stage test facility for refurbishment and modification on November 15, 1967. Refurbishment and modification were discontinued for a period of time but were renewed on January 30, 1968. On April 1, 1968, the stage began preparation for post-static checkout, scheduled at that time to commence on April 22, 1968. Post-static checkout was deferred at NASA's request and, at the close of the reporting period, is scheduled to commence on July 8, 1968.

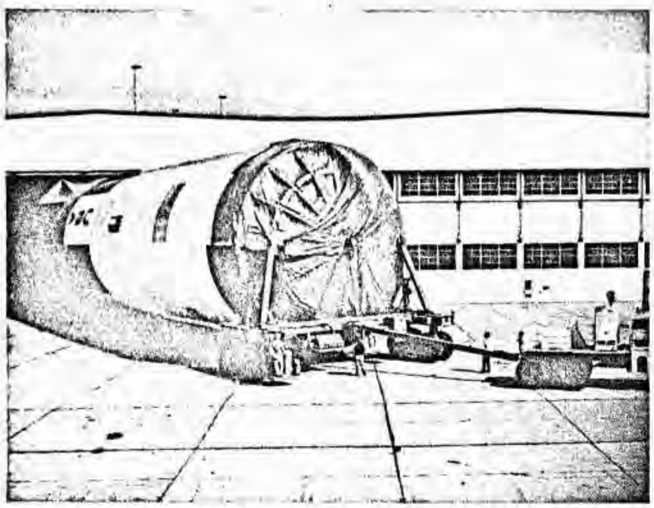


Figure 2-5 S-IC Stage Being Moved From Factory

S-IC-6

The S-IC-6 was undergoing post-manufacturing checkout at the end of FY 1967. Post-manufacturing checkout was completed on July 24, 1967, with customer acceptance of the simulated static firing test. (Maximum incentive points of 299.6 were earned for attainment of this milestone.) The stage remained at Michoud through February 1968 for storage, installation of Systems "A" instrumentation (hardwire instrumentation for static firing purposes only), and incorporation of committed modifications. It was shipped to MTF on March 1, 1968 and erected in the test stand on March 4, 1968.

Stage power-on was accomplished on April 4, but on April 23, at the direction of the Program Executive, S-IC-6 acceptance tests were suspended so that proposed POGO suppression modifications, resulting from AS-502 flight analysis, could be studied for possible incorporation and testing on the S-IC-6 prior to the decision to incorporate them on the S-IC-3. A review of changes affecting the stage was then conducted to decide which changes would be practicable for accomplishment prior to a later static firing schedule. At the end of the reporting period, S-IC-6 static firing was scheduled for eary August 1968.

S-IC-7

Post-manufacturing checkout of the S-IC-7 began on August 14, 1967. This activity was completed on November 13. Maximum incentive points were earned for achievement of this milestone, but they are being held in abeyance pending negotiation of SA MICH-662 (see page 3). The stage was placed in storage on November 22, 1967. Figure 2-6 shows the S-IC-7 in storage in the Michoud factory building. On March 13, 1968, the S-IC-7 began installation of Systems "A" instrumentation (hardwire instrumentation for static firing purposes only) and incorporation of committed modifications. At the close of FY 1968, the stage was scheduled to be delivered to MTF (to begin preparation for static firing) on September 13, 1968.

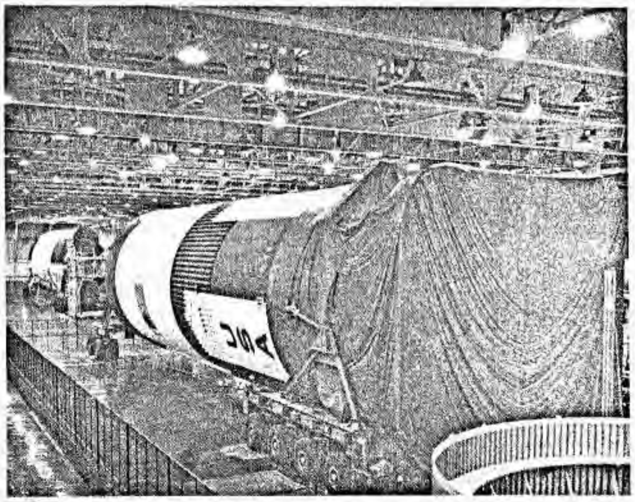


Figure 2-6 S-IC-7 Stored in Factory Building

S-IC-8

Vertical assembly of the S-IC-8 was completed September 11, 1967 and horizontal assembly began the following day. (Figure 2-7 shows the S-IC-8 in vertical assembly and Figure 2-8 shows it being removed from the vertical position in the Michoud VAB.) Due to modifications to the working schedule, the vehicle remained in a factory work position for horizontal assembly and modification incorporation until May 10, 1968, when it was transferred to a factory storage position where it will remain for an indefinite period.

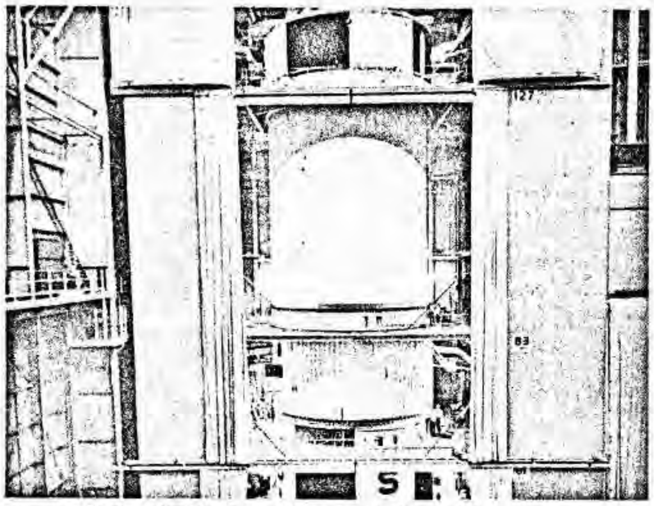


Figure 2-7 S-IC-8 in Vertical Assembly

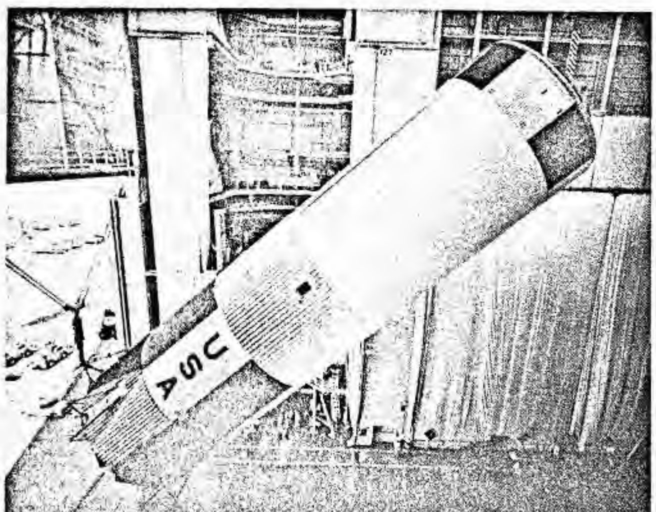


Figure 2-8 S-IC-8 Being Removed From VAB

Several proposals have been made during the past year to initiate a factory verification test with the S-IC-8 vehicle. This test would consist primarily of a proof pressure test to check for leakage in the LOX and fuel tank systems. At one time, in mid-March 1968, all preparations were completed and readiness reviews were held with the Michoud Operations Manager, but performance of the test in the factory was suspended at the last moment by NASA directive.

S-IC-9

All major structures for the vehicle were completed furing FY 1968. Vertical assembly was completed February 22, 1968, and horizontal assembly began the following day. Horizontal assembly was completed June 17, 1968, and the vehicle began a period of modification incorporation. Figure 2-9 shows F-1 engine installation in an S-IC stage during horizontal assembly. Delivery to the Michoud Systems Test organization for post-manufacturing checkout is presently scheduled for November 14, 1968.

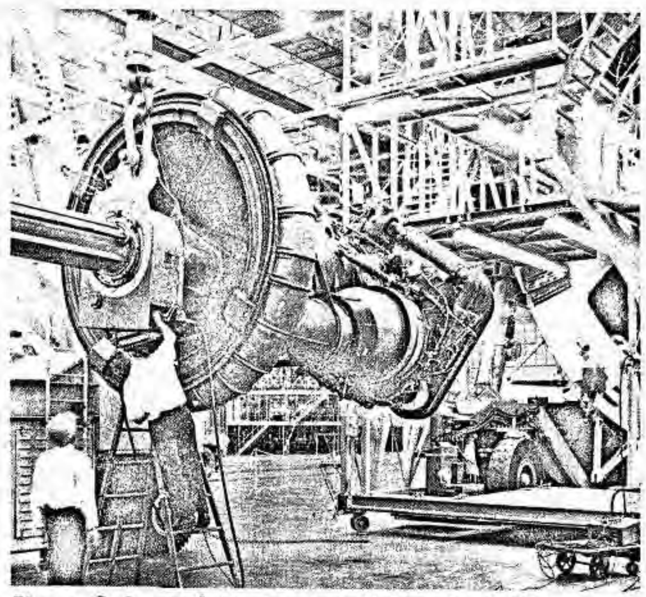


Figure 2-9 F-1 Engine Installation in S-IC

S-IC-10

All major structures for the S-IC-10 were completed during the past year. Figure 2-10 shows completed S-IC propellant tank being moved from the Michoud factory building. Vertical assembly of the stage was completed June 18, 1968, and horizontal assembly began the following day. Delivery to Systems Test for post-manufacturing checkout is presently scheduled for January 22, 1969.

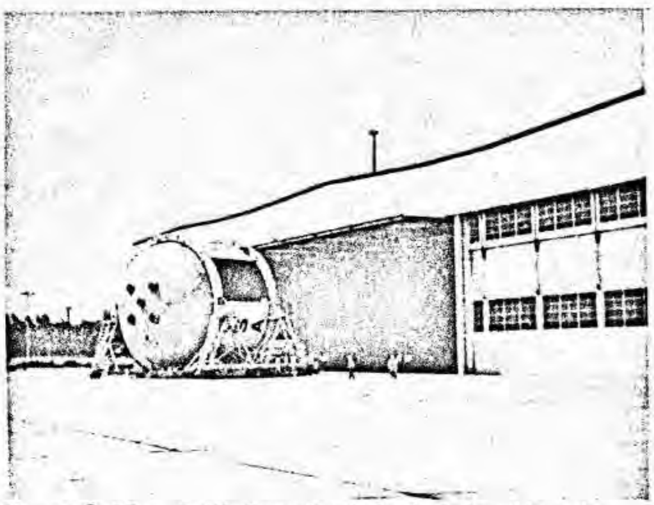


Figure 2-10 S-IC Propellant Tank Being Moved From Factory

S-IC-11 THROUGH -15

Assembly was started on the S-IC-11 through S-IC-14 vehicles during the past year. Several of the major structures for the S-IC-11 have been completed. Assembly is proceeding as scheduled on the S-IC-11 through -15. Figure 2-11 gives the percentages of completion on S-IC-11 through -15 major structures at the end of the report period.

MAJOR STRUCTURE ASSEMBLIES	STAGE				
	11	12	13	14	15
THRUST STRUCTURE	100%	99%	46%	16%	0%
FUEL TANK	100%	98%	67%	35%	3%
INTERTANK	100%	100%	61%	0%	0%
LOX TANK	100%	92%	53%	17%	0%
FORWARD SKIRT	100%	99%	42%	0%	0%

Figure 2-11 Percentage Complete - Major Structures - June 27, 1968

GROUND SUPPORT EQUIPMENT

KSC EQUIPMENT

Thirteen end items required by MICH 112, CCP 9001, were delivered during the past fiscal year. Fifteen end items remain to be delivered.

The last three units of Modification 123/185 umbilicals were delivered in the past fiscal year. These units included one refurbishment unit for RP&VE and two KSC general units.

During the past year, CCP 9289 (launch support hardware at KSC), which established Michoud as the focal point for umbilical refurbishment, was initiated. Under this concept, all five of the S-IC umbilical carriers installed on a LUT will be removed from that LUT after a launch and returned to Michoud for refurbishment and updating. The present contract provides that a set of umbilicals be supplied for launches through the S-IC-15 with replacement of the units on each LUT after the last presently scheduled launch. Assembly is now in progress on sets for the S-IC-4 and -5 and production support.

The remaining three units of Modification 122/174 pneumatic equipment were deivered to KSC during the past fiscal year.

The helium and nitrogen sections of the LUT #3 pneumatic console were returned to Michoud Operations by Engineering Laboratories in mid-August 1967 following completion of a life-cycle test. Refurbishment and updating of the two units was accomplished on an accelerated basis, and the last of the two units was delivered to KSC on January 5, 1968. The third unit, the LUT Number 3 pneumatic checkout rack Number 2, was delivered to KSC on January 17, 1968.

S-IC STAGE SUPPORT EQUIPMENT

a) S-IC stage transportators — Due to the revisions to the vehicle delivery schedule during the past year, S-IC stage transporters have become the pacing item in the completion of vertical assembly at Michoud. This is due primarily to the length of time the transporters are required to stay at KSC, and the number of vehicles in process at MAF in the horizontal position. At present, plans are being made to work around the transporter shortage problem by placing vehicles in horizontal assembly on storage stands. To provide a more definite resolution to this problem, action will also be taken in the near future to attempt to have transporters released from KSC as soon as a vehicle is erected.

b) S-IC forward handling rings — The provisioning of handling rings to support the lift and join of the forward skirt has become an area of concern during the past year. Because the S-IC-3 handling ring could not be released in time to support the S-IC-10, it became necessary to erect the S-IC-F vehicle in the VAB and change out its aluminum handling ring for an MSFC supplied steel handling ring. Yet even with this measure, it was necessary to waiver post proof-load test inspection in order to lift the forward skirt on schedule.

The S-IC-3 handling ring is now programmed for turnaround utilization on the S-IC-11 vehicle, and again does not support the MAF demand date. However, efforts are now being made to accelerate release of this handling ring from KSC, and with the use of premium time effort during recycle test, the problem may be resolved.

DESIGN AND ENGINEERING

S-IC ENGINEERING DOCUMENTATION

Engineering documentation releases for FY 1968 were of a sustaining nature and consisted of retrofit and other committed changes. There were 3679 documentation packages released, of which 1961 were retrofits.

Documentation releases associated with change action consisted of the completion of documentation for 117 changes as listed in Appendix A. Changes initiated included 185 ECPs, 25 PRRs and 8 CCPs for a total of 218 changes as listed in Appendix B.

During FY 1968, Boeing Engineering worked closely with the Computer Sciences Applications organization to assure that the Automatic Release System conversion from Honeywell to Univac computing equipment was successful. As a result, a high level of confidence can now be placed in the Automatic Release System, and the quality and timeliness of the required reports are excellent.

S-IC STAGE WEIGHT STATUS

The final S-IC-1 stage dry weight as determined by

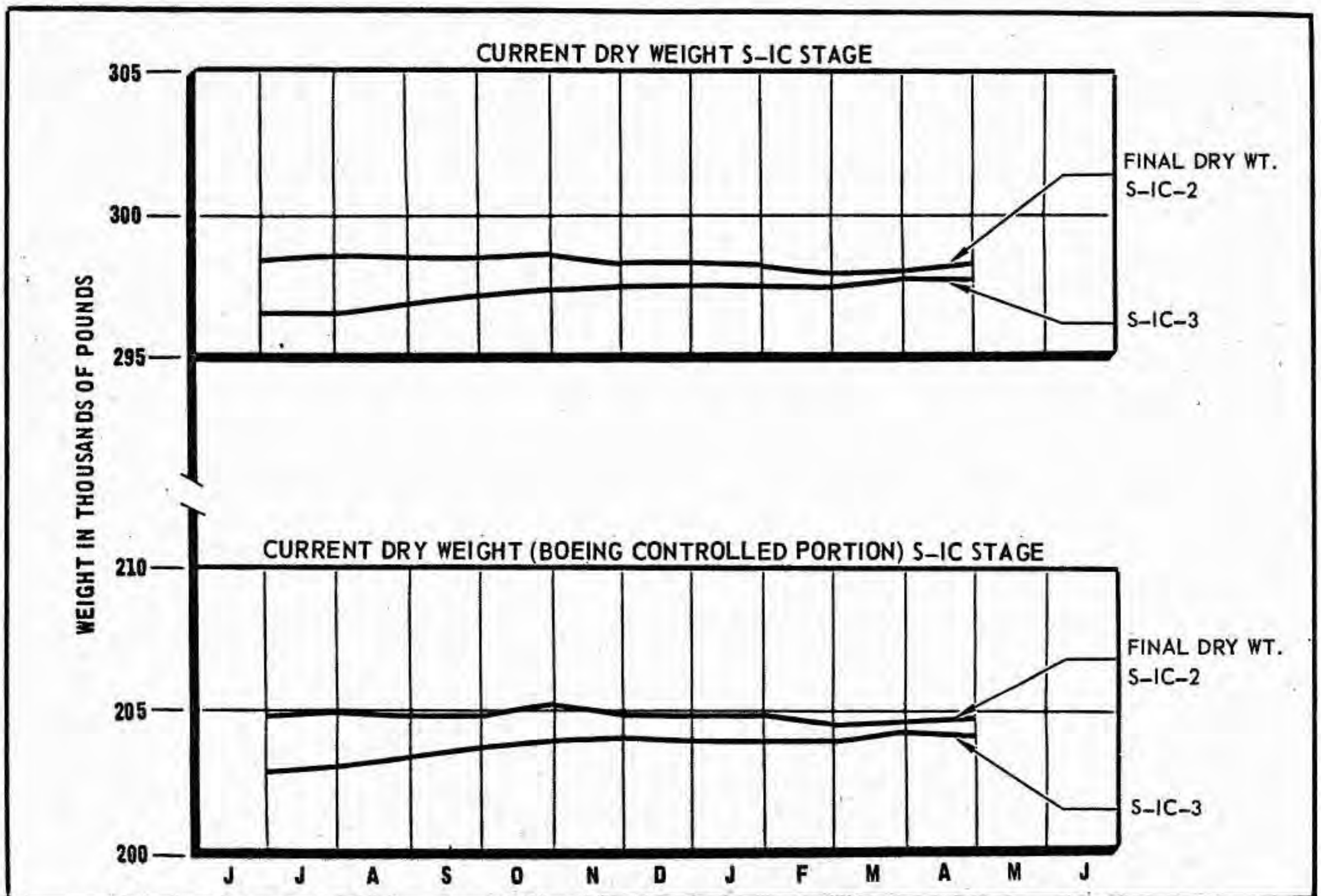


Figure 2-12 S-IC-3 Versus - 2 Dry Weight Status

the weight and balance log was 307,550 pounds, 2266 pounds over the Contract End Item (CEI) specification weight of 305,284 pounds. The final S-IC-2 stage dry weight as determined by the weight and balance log was 306,159 pounds. This final weight is 137 pounds under the CEI specification weight of 306,296 pounds. The calculated dry weight of the S-IC-3 stage for which Boeing has responsibility has increased 353 pounds during this reporting period. The F-1 engine weight did not change. At this time, Boeing is 669 pounds under the specification weight for S-IC-3. Variations in S-IC-3 versus S-IC-2 dry weight are plotted in Figure 2-12. These weights do not include R&D instrumentation, which varies with each vehicle (S-IC-2 through S-IC-5).

Figure 2-13 represents the CEI specification weight, CEI specification weight (less engines), Boeing current weight (R&D less engines), current dry weight (less R&D), and dry stage weight (R&D) for stages S-IC-2 through -15. A comparison of current weight versus CEI specification weight for the S-IC-3 is included.

S-IC STAGE DESIGN

SERVOACTUATORS

Hydraulic Research servoactuator spring failure — During pre-static firing checkout of the S-IC-5 at MTF, the locks-off null position test revealed that the Hydraulic Research (HR) servoactuators on engine number four were not within specified limits, thereby causing erratic response. The cause of this out-of-null positioning was traced to broken torsional springs that are designed to preload the rotational mechanical feedback mechanism in one direction to remove backlash in this portion of the actuator control loop. Investigation revealed that the spring failure was due to contamination during heat treatment.

As a result, HR servoactuators on the S-IC-1 were replaced with Moog servoactuators, and we were directed by NASA to replace the material used in the failed spring (17-7PH steel) with a material not susceptible to stress corrosion. The actuators removed from S-IC-1 were used on the S-IC-2 after incorporation of improved process 17-7PH steel springs, and Inconel 718 was selected as the new material for the S-IC-3 and subsequent stages.

Servoactuator stress corrosion — Failure of a Moog 50M (MSFC procured) servoactuator occurred during bench testing at MSFC in February 1968. Several other failures were subsequently discovered on actuator bodies at both Moog and MSFC. Metallurgical analysis of the first failure indicated that stress corrosion cracking occurred at the parting plane of the forged body, which was constructed of 7075-T6 aluminum. Because the S-IC-2 had four actuators of this model installed, a change was initiated to replace them with 60B (Boeing procured) servoactuators. Boeing procured servoactuators were acceptable because additional processing controls, to minimize residual tension stresses on the surfaces of the actuator bodies, had been imposed during fabrication. As a result of the above events, both Moog and Hydraulic Research (HR) servoactuators are being redesigned, and a test program for comparing stress corrosion resistance of 60B and 50M actuators has been initiated. 7075-T73 aluminum will be used as body material for both the Moog and HR servoactuators. The Moog cylinder will remain 4340 steel while the HR cylinder will be changed to 7075-T73 aluminum. Miscellaneous other components will require processing modification to preclude stress corrosion. Test evaluation procedures for comparing 60B and 50M servoactuators will include accelerated stress corrosion testing by alternate immersion in 3.5 percent salt water and X-ray diffraction measurements to determine residual stress levels on actuator body surfaces. Completion of the actuator redesign program is scheduled to provide production parts for use on the S-IC-6. The 60B (Boeing procured) - 50M (MSFC procured) comparison study is scheduled for completion in September 1968.

Servoactuator redesign to eliminate stress corrosion and hydrogen embrittlement — Change Order MICH 738 directed Boeing to redesign servoactuators to eliminate all stress corrosion and hydrogen embrittlement susceptible materials. A review of all materials used in servoactuators has been conducted and material changes will be accomplished.

Servoactuator electrical filter design—During S-IC-1 static firing, unexplained electrical noise in the Moog servoactuators input signal, accompanied by random movement of the actuator, was experienced. Investigation revealed that the observed noise resulted from vibration of the servoactuator torque motor that occurred in sufficient magnitude to saturate the flight amplifier and cause loss of actuator control. A change was initiated to reduce the noise level of Moog servoactuators on S-IC-3 through -10 by the use of a filter assembly that has been successfully tested in actual firings on the single-engine stand at MSFC during June 1967. On August 31, 1967, S-IC-5, the first stage equipped with the flight configuration

VEHICLE	CEI SPEC. WEIGHT	CEI SPEC. WT. (LESS ENGINES)	BOEING CURRENT WEIGHT (R&D) (LESS ENGINES)	DRY STAGE (LESS R&D)	DRY STAGE (R&D)
S-IC-2	306,296	213,796	212,667	298,209	306,159*
S-IC-3	305,498	212,998	212,329	297,857	305,788
S-IC-4	297,894	205,354	202,539	290,067	295,474
S-IC-5	297,858	205,354	202,018	289,721	294,898
S-IC-6	291,891	199,324	196,659	289,134	289,134
S-IC-7	291,891	199,391	196,453	289,155	289,155
S-IC-8	291,891	199,391	196,454	289,410	289,410
S-IC-9	291,854	199,354	196,453	289,155	289,155
S-IC-10	292,111	199,611	196,557	289,259	289,259
S-IC-11 THRU S-IC-15	292,111	199,611	196,557	289,259	289,259

* AS REPORTED BY THE FINAL WEIGHT AND BALANCE LOG.

S-IC-3 WEIGHT STATUS	12-30-67	6-27-68	NET CHANGE
I. CURRENT WEIGHT			
A. DRY STAGE (INC. R&D)	305,435	305,788	+353
B. DRY STAGE (INC. R&D) (LESS ROCKETDYNE)	211,976	212,329	+353
C. RESEARCH AND DEVELOPMENT (R&D)	7,931	7,931	0
II. CEI SPECIFICATION WEIGHT			
A. CEI SPEC. WEIGHT (INC. R&D)	304,681	305,498	+817
B. BOEING PORTION, CEI SPEC. WEIGHT (INC. R&D)	212,181	212,998	+817
C. R&D, CEI SPEC. WEIGHT	7,847	7,847	0

RESEARCH AND DEVELOPMENT INSTRUMENTATION (R&D) (CURRENT)

S-IC-2	7,950 POUNDS
S-IC-3	7,931 POUNDS
S-IC-4	5,407 POUNDS
S-IC-5	5,177 POUNDS

Figure 2-13 Breakdown of S-IC Stage Weights

filter assembly, was static fired at MTF, and analysis of thrust vector control data showed that actuators equipped with the filter assembly performed within end item test plan requirements.

ELECTRICAL DISTRIBUTORS

During FY 1968 the Electrical Distributor Qualification Test Report was revised to incorporate certain exaggerated environmental test results and minor changes requested by MSFC, including changes to determine the effect of foam in electrical distributors. Tests were conducted on a distributor without foam, and results indicated that foam did not affect component or structural dynamic responses. To eliminate concern with foam expansion, deletion of BMS 8-38 Sta-foam from electrical distributors was proposed. However, this modification was disapproved by NASA.

Inspection of printed circuit boards in electrical distributors revealed that some solder joints were cracked. Analysis indicated that the cracked solder joints were caused by differential rates of thermal expansion between component leads and board material. Environmental tests, thermal shock, and vibration verified the functional integrity of printed circuit boards with cracked solder joints. To eliminate cracked solder joints, manufacturing processes were revised to reduce stress in solder joints, and redesign of printed circuit board was initiated to provide strain relief for susceptible solder joints.

An electrical distributor redesign study was initiated during the reporting period. This study will define distributor design criteria and investigate application of advanced packaging, interconnection, and termination techniques to electrical distributors. The study goal is to determine methods of improving distributor maintainability.

During rework of S-IC-3 spare distributors to S-IC-1 stage configuration, misaligned and protruding contact members were noted in methode printed circuit card connectors. Subsequent discrepancy inspections revealed that these conditions were prevalent in a large percentage of installed connectors and in new connectors in stores. Cracked contacts were also noted in a number of connectors during these inspections. Investigation revealed that the conditions were not design discrepancies, but resulted from inadequate control of materials and dimensions, which is inherent with parts procured to vendor part numbers with no control by the procuring activity. To provide tighter controls and to assure production of satisfactory parts, a connector specification was originated, and a change was initiated to replace the FD744-3S-SF connectors with MBC455 connectors on S-IC-3 and subsequent stages. Since no failures of the FD744-3S-SF connectors had occurred during qualification, reliability, development, subsystem or stage level tests, or during numerous static firings, they were retained on S-IC-1 and -2.

Figure 2-14 illustrates the S-IC power distribution system.

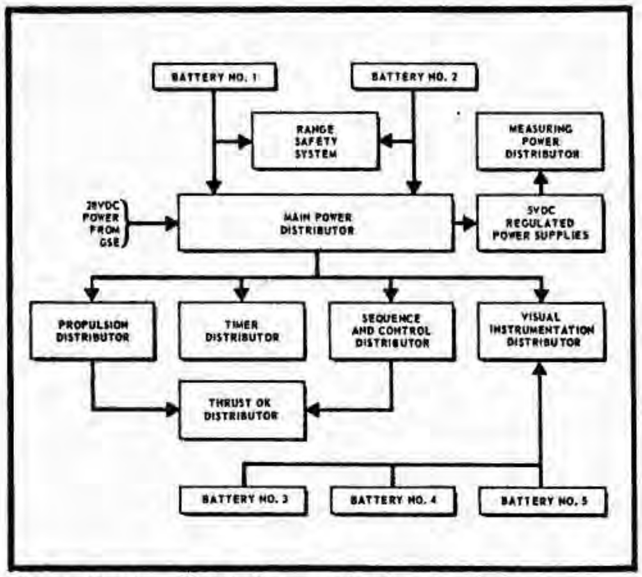


Figure 2-14 S-IC Power Distribution System

LOX FILL AND DRAIN VALVES

During countdown demonstration testing of the AS-501, LOX fill and drain valves were found to be leaking. Analysis of the valve failure revealed a circumferential crack in the main seal, which is believed to be caused by severe thermal stresses induced in the teflon seal when it contracts, at cryogenic temperatures, at a rate faster than the surrounding metal. These stresses could also be enlarged by tolerance buildups, high flow rates, or valve cycling. This failure could not be duplicated during follow-up testing by the vendor, Parker Aircraft Company. Boeing assumed the risk of flying the S-IC-1 and -2 without changes to these valves. These decisions were based on the following:

a) The valve has been installed in 18 locations per stage on the S-I and S-IB stages with no similar failures experienced;

b) Only two other failures (one seal cracked and one showing evidence of a crack starting) of this type had been experienced on the S-IC stage;

c) A review of quality records was unable to attribute the failure to any specific lot of seals. Visual examination of approximately eight other seals, including one from the same lot as the S-IC stage valves, revealed no additional cracked seals; and

d) Analysis indicates a high probability that any leakage would be GOX rather than LOX in the event of a cracked seal in installed valves. In addition, the SA-501 mission revealed only gaseous leakage in the valve area.

S-IC PROPELLANT DISPERSION SYSTEM

Installation interference — As a result of the problems encountered during installation of the Flexible Linear Shaped Charge (FLSC) on both the S-IC-1 and -2, the ordnance cowling installation has been redesigned. The redesigned cowling consists of an open-faced box with cover plate, and allows lateral insertion of the ordnance. Rework operations on the S-IC-3 ordnance included cleaning of the existing propellant tank cowling and replacement of the cowling on the forward skirt and intertank with the open-face and cover-plate configuration mentioned above. The propellant tank cowling was reworked rather than removed because this cowling is bonded to the tanks and rebonding requires environmental control that is not available at KSC. On S-IC-4 and on, the existing bonded cowling is being replaced with the new, open-face cowling.

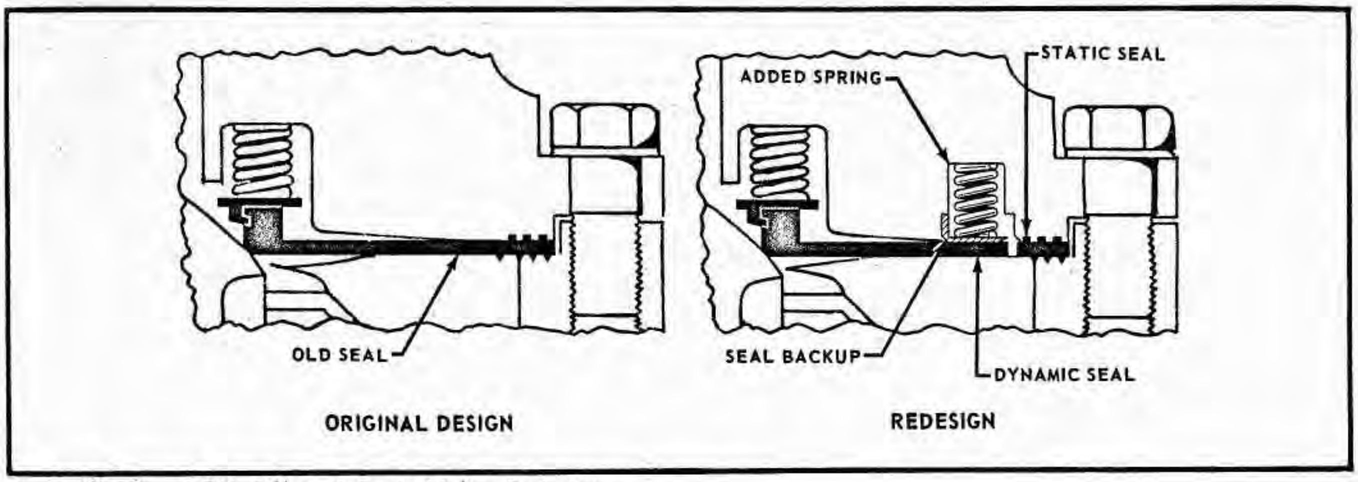


Figure 2-15 LOX Fill and Drain Valve Redesign

The vendor has redesigned the main seal area by splitting the existing one-piece seal into an internal dynamic seal and an external static seal (see Figure 2-15). An additional row of circumferential springs on a metal seal back-up contains the internal dynamic seal and provides the sealing surface. The new design has been subjected to limited qualification tests to assure that all design requirements can be met, and the redesigned valves will be incorporated into S-IC-3 and subsequent stages. However, qualification testing revealed that existing test procedures could allow a valve to qualify and yet experience leakage in stage use after repeated dry cycling during stage test and checkout. This condition has been evaluated by Engineering with the conclusion that the condition is an acceptable risk for the S-IC-3 flight. However, efforts to resolve the problem are continuing and Engineering will initiate changes proposing the development and procurement of an improved design.

Support bracket failure — During a routine inspection of the S-IC-1 fuel dispersion system installation, it was discovered that 31 support brackets had become unbonded. Investigation concluded that this failure resulted from sustained load application to the support brackets. This situation has been avoided on subsequent vehicles by assuring a clearance between the cowling and the support strap. The failures on the S-IC-1 were dispositioned by removing the failed brackets and support straps. On the S-IC-2, failed brackets were removed, all support straps inspected, and shims were installed to provide desired clearance.

An inspection of the support bracket installation on S-IC-3 and -4 revealed only one failed bracket on the

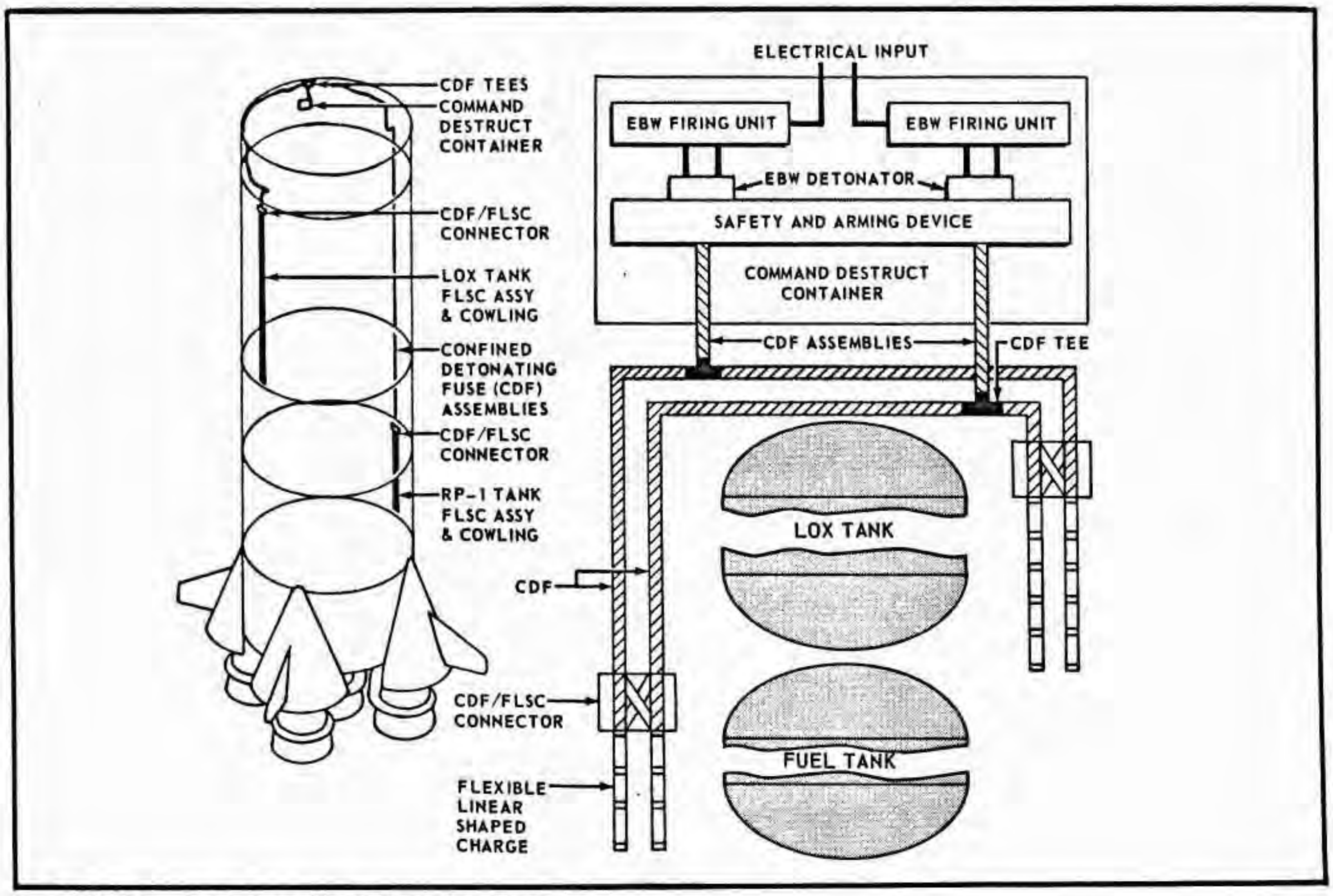


Figure 2-16 S-IC Propellant Dispersion System

S-IC-3 and none on the S-IC-4. All support strap installations were inspected and reworked as required on all subsequent stages. Figure 2-16 is a schematic of the S-IC propellant dispersion system.

PROCEDURES FOR CHANGE-OUT OF TIME/CYCLE SENSITIVE ELEMENTS

During FY 1968 a change was initiated to resolve difficulties encountered in controlling time, cycle, or age sensitive S-IC parts, and to implement a new 50 percent life requirement at stage delivery. Life limit requirements, which were originally listed in Document D5-12713, will be released as new Class I documentation. The new Class I documentation will define the life limits and life apportionment by test phase of all S-IC time, cycle or age sensitive parts. This documentation will also define the disposition of parts at the end of life limits and, if parts can be reworked, the work necessary to restore the time, cycle, or age life to zero.

LOX ENGINE CUTOFF SENSORS

Solar Cell Redesign — The LOX engine cutoff sensor solar cell has been replaced with a solar cell that is reliable at cryogenic temperatures. This action was taken because the previous solar cell had a history of failures.

Center Engine Redundant LOX Cutoff Sensor — A new optical LOX engine cutoff sensor was developed, for installation in the center engine LOX duct, to provide a redundant method for initiating center engine shutdown upon LOX depletion (see Figure 2-17). This change is effective on S-IC-2 and S-IC-4 and subsequent stages. This change is not necessary on the S-IC-3 because the center engine on this stage is shut down by a timed signal from the instrument unit.

LOX VENT AND RELIEF VALVES

A redesign of the position switches on the LOX vent

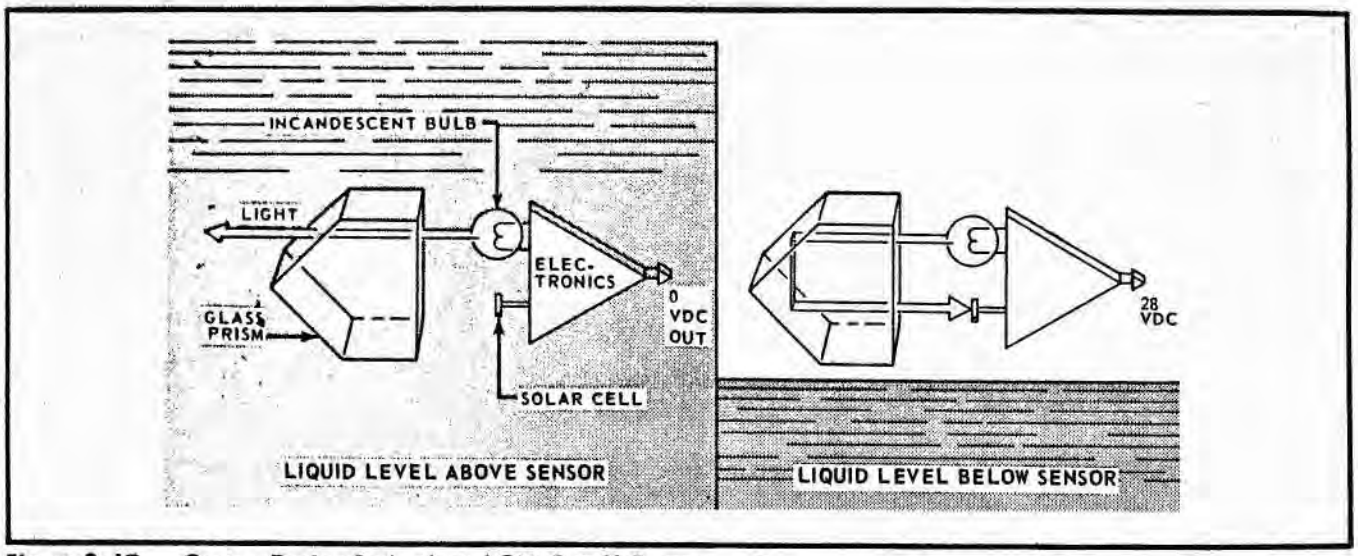


Figure 2-17 Center Engine Redundant LOX Cutoff Sensor

and relief valves was initiated to resolve the following problems:

a) Oil contamination could result in switch failure causing countdown delay due to the LOX vent valve position interlocks; and

b) The actuator post-to-spring spotwelded joint failed during the S-IC-2 CDDT, resulting in an electrical short and loss of "open" position indication, which caused CDDT delay.

PARKER VALVES STRESS CORROSION

To eliminate the possibility of stress corrosion in the Parker Normally Closed (N.C.) Fill and Drain Valves (LOX and fuel), N.C. LOX Interconnect Valves, and Normally Open (N.O.) LOX Interconnect Valves, the actuator housings of these valves were reheat treated to a 7075-T7351 condition. This change was initiated on stages S-IC-2 and on because failure of the actuator housings could result in loss of actuator pressure that would cause closing of the N.C. valves and opening of the N.O. valves. If this occurred during fuel and/or LOX fill operations, the fuel and/or LOX fill and drain lines could rupture because the GSE would not be able to shut off the fuel/LOX supply in time to prevent excessive surge pressures.

LOX INTERCONNECT VALVE

During the reporting period three Whittaker LOX interconnect valve shafts failed, and a fourth was found to have circumferential cracks, that were identical to those found on the three failed shafts, indicating a potential failure. Of the three valves that failed, two failed during functional testing, and the third failed during reliability test cycling. Seven other valves were disassembled and their shafts were magnetically inspected. Of these seven, one was found to have circumferential cracks on the shaft.

To prevent such failures, which would render the valve inoperative, the shaft material was changed (S-IC-2 and on) from 440C to Inconel 718, heat treated to 180,000-200,000 psi.

F-1 ENGINE LOX SEAL PURGE REGULATOR

The LOX Seal Purge Regulator is a flight critical component that has been subjected to prolonged operating time during prelaunch test activities at KSC. Because this additional operating time was not anticipated during initial design and testing, a reliability test program was initiated to simulate five complete life cycles. There were no critical failures on three test regulators each of which was subjected to a total of 840 hours of operation to satisfy the reliability test that simulated static firing, prelaunch, flight environments, and service times. A burst test will be conducted using one of the reliability test regulators to determine any detrimental effects the reliability life cycling might have had on the regulator. This test is scheduled to begin in August 1968.

RETROROCKETS

During FY 1968 there have been several major problems concerning S-IC retrorockets. These problems and their resolution are:

Propellant cracks, voids, and separation — Problems of this type have occurred on S-IC retrorockets. To solve such problems as they arise, Thiokol Chemical Corporation (the vendor) details propellant problems on Material Review Board (MRB) forms, submits the MRB forms to Boeing Engineering for approval, and then proceeds to take the approved corrective action.

Localized thin areas in rocket cases — During a drawing operation that was used in the manufacture of rocket cases, longitudinal thin strips, called creases, were generated in the case walls. To resolve the problem, a stress analysis was made on each case to determine the maximum pressure each would withstand. The three cases with lowest wall thickness in the creases were then hydroburst. These operations indicated that the remaining creased cases were acceptable insofar as design strength requirements are concerned.

Overdrilled holes in rocket cases and out-of-round rocket cases — These problems were resolved by stress analysis and the test firing of one rocket. The test rocket had an unacceptable out-of-round condition, and the 1/4 - 28UNF holes in the head end were overdrilled. Thiokol created a "worst possible" condition in the rocket by extending the already overdrilled holes through the case and into the propellant. The bolts were installed and the rocket was fired resulting in nominal performance parameters and no evidence of case deterioration due to either discrepancy.

S-IC-1 and S-IC-2 flight retrorocket performance exceeded prediction — Both the S-IC-1 and S-IC-2 flights have revealed retrorocket motor performance in excess of that predicted. Pressure transducers are used in flight to measure the performance of each of the eight retrorockets. Investigation revealed that Thiokol uses tubing filled with grease to measure performance while the Boeing instrumentation is coupled directly to the pressure chamber and exposed to direct pressure and temperature transients. Because flight performance was predicted on Thiokol measurements, it was necessary to run comparative instrumentation tests. The results of this testing indicate that flight instrumentation read high in an indication of excessive performance. Final resolution of this problem is not complete for this reporting period.

POGO

During the S-IC-2 flight, in the period from T+110 seconds to T+135 seconds, a significant longitudinal oscillation of 5 cps built up and then died out after reaching maximum at T+126 seconds. Acceleration, thrust, and propellant pressures were all in phase, indicating a closed loop instability, called POGO, that limit cycled. Accelerations reached 0.8 g's peak-to-peak at the Command Module interface and 0.4 g's peak-to-peak on the S-IC stage. These oscillations can affect payload structure and impair the effectiveness of the astronauts. The solution to this problem involves a change to the LOX delivery system to effect a change in propellant line frequencies, thereby decoupling the oscillations and establishing stability. A full-scale analysis is underway to determine and incorporate the solution to this problem prior to the S-IC-3 launch.

Several POGO solutions have been considered, and the two prime corrective systems currently being considered are a helium injection system (ECP 0442) and prevalve accumulators with helium injection (ECP 0446). A brief description of these systems follows.

a) Helium Injection System (ECP 0442)

   This system involves injection of gaseous helium into the upper portion of the LOX suction ducts through existing bosses of the four outboard engines during the time that POGO could occur. The helium supply will be tapped off the high pressure side of the stage helium manifold, then routed through shutoff valves, regulators, and orifices to manifolds located in the intertank area, and then through check valves into the suction ducts.

b) Helium Prevalve Accumulator System (ECP 0446)

   This system involves injection of helium gas into the LOX prevalve cavities, thus enabling the prevalves to serve as accumulators. Onboard helium will be provided by tapping off the high pressure side of the helium manifold.

As a result of the POGO resolution effort an extensive testing program has been undertaken by Boeing Schedule I. Numerous component tests, development, reliability, and qualification, have been initiated to help resolve this problem. A LOX suction duct flow test fixture, which is being used to test dynamic characteristics of suction lines as a result of proposed POGO suppression systems, has also been constructed at Michoud.

AIR SCOOP ELIMINATION

MSFC has agreed to delete the base air scoops for stages S-IC-3 and on. This is being done because analysis indicates that the base air scoops used on the S-IC are not required to maintain temperatures in the base region within acceptable levels. The S-IC-1 flight verified this analysis when the data was examined and the actual base environment was found to be much less severe than the design environment. This data indicated that air scoops were not necessary for cooling. Scoop elimination was also desirable from the standpoint of weight (approximately 500 lbs.), cost, and possible interference with LUT hardware during lift-off; and a change to provide a rain cover over the scoops to prevent deflection of rain water on the insulated base area surfaces will also be avoided by scoop elimination. Data from the S-IC-2 flight confirmed that the scoops are not required. The base environment on the S-IC-2 was more severe than S-IC-1, as expected, but still less than design levels.

HEAT SHIELD

Heat shield material — The basic ingredient of the M-31 ceramic insulation originally used on the heat shield was Tipersul. Therefore, upon notice from the Dupont Company that production of Tipersul would be discontinued, Boeing stockpiled a supply to support estimated S-IC requirements. However, due to an unexpected high usage rate in production and refurbishment operations, the stockpile proved insufficient.

As a replacement for M-31, the MSFC M&P Laboratory developed a new insulation, FTA 442A. The Rohr Corporation performed development tests and fabricated production panels with the new insulation for qualification. Tests were run subjecting the panels to the predicted flight environments. As a reliability test, panels were subjected to an additional 140 seconds of acoustic test with minor damage. In a separate test, engine shutdown followed by a flight cycle was simulated with favorable results. Based on preliminary data and reports, the new material appears more than adequate for flight use, and will be used, rather than Tipersul, for the heat shields on S-IC-10 through -15.

Heat shield delamination — During the S-IC-1 flight, two thermocouples located on the heat shield at holddown Position III indicated a sharp temperature rise at approximately T+110 seconds. During the S-IC-2 flight, two thermocouples located on the heat shield at holddown Position II indicated a sharp temperature rise at T+96 seconds. These anomalies were attributed to cracking and/or delamination of the M-31 ceramic insulation. TV camera film at Position I on the S-IC-2 flight showed a triangular area of delamination approximately 10 inches on each side, but no thermocouples are installed in this area to record the effects of the delamination. This problem appears to be localized because average coldside and brazeline temperatures were 72°C and 185°C, respectively. These low average temperatures indicate that, even though local damage may have occurred, the heat shield remained effective. Additional vibration and acoustic measurements will be included on the S-IC-3 heat shield to determine the cause of the delamination.

FORWARD SKIRT TEMPERATURE

Insulation was applied to the S-IC-1 forward skirt to prevent high temperatures. Data received from the S-IC-1 flight indicated that temperatures were lower than anticipated. However, because the insulation thickness was not strictly controlled, this data is not completely reliable. Therefore, controlled thickness insulation will be placed on the S-IC-3 at thermocouples, and temperature data will be gathered during its flight. If this S-IC-3 flight data indicates that insulation is not required, it will be eliminated from S-IC-4 and subsequent stages.

STAGE RAINWATER DAMAGE

While the S-IC-1 was on the pad at KSC, rainwater entered the thrust structure area through the electrical cabling access opening underneath the electrical tunnel and caused water damage to certain electrical components. To prevent rainwater from entering the stage, a type of adhesive tape was applied to the electrical and pressurization tunnels and other affected areas on S-IC-1 through -3. Because this tape application is a temporary measure, rubber and metal seals will be installed on the S-IC-4 and following stages.

FORWARD UMBILICAL DOOR

Film taken of the launches of the S-IC-1 and -2 disclosed that the forward umbilical door interfered with the umbilical disconnect cable at liftoff and remained open during flight. Although no apparent stage and only slight umbilical damage resulted, the forward umbilical door was redesigned to prevent interference with the disconnect cable and to ensure proper closure of the door during flight. The change was made for S-IC-3 and on, but the change could not be made to the S-IC-2 due to schedule impact.

DESICCANT FILTER UNITS

The desiccant filter unit is comprised of a particulate filter, which is 100 percent efficient in removing particles 50 microns or larger, and a silica jell desiccator which has the capability to reduce the relative humidity of inflowing air from 95 percent to 65 percent. NASA has reviewed the application of desiccant filter units to be used on the S-IC propellant tanks and approved their usage during all MAF operations. This change constitutes a major cost reduction because the previously used positive pressurization system required constant monitoring of the equipment. The desiccant filter system requires monitoring only to the extent of changing out the desiccant portion approximately once each seven to ten days. The usage of the desiccant filter system on propellant tanks of the S-IC stage in storage was applied earlier, and its usefulness and convenience has been established. Recently, relative humidity samplings of the tank interiors were found to be well below a new customer requirement of 40 percent maximum.

SLOW RELEASE MECHANISM

Boeing Schedule I and II were concerned about the number (12) of slow release mechanisms (SRM) and the possibility of inadequate lubrication of the SRM with the KSC procedure of greasing after SRM assembly of the pin in the die.

Three spares S-IC-2 slow release mechanism, lubricated to a new KSC procedure, were pulled in the MAF laboratory. The peak extrusion loads of 66, 63, and 69 kips were in the low portion of the range of peak loads obtained during the developmental test program. Loads analyses, with 12 SRMs having these latest test data characteristics, indicated that although the vehicle responses have increased, in all cases these vehicle responses remained within design limits. Also, the time required for SRM extrusion had dropped indicating less probability of AS-502/LUT interference than would have existed with a 16 SRM configuration having peak force values of the original specification. Therefore, a properly instrumented 12 SRM configuration using the new KSC SRM lubrication procedure was used on S-IC-2 and will be used on S-IC-3.

INSTRUMENTATION

Flight measurements — On the S-IC-1 flight there were 854 active and 18 waived measurements. Of the 854 active measurements, 831 provided valid data. The S-IC-2 flight had 880 active and 13 waived measurements. Of the 880 active measurements, 865 provided valid data.

Thermocouple bond failure — Thermocouples bonded to the LOX and fuel tank surfaces became detached during flight and gave erroneous data. Improved bonding methods have been developed and all tank surface measurements on S-IC-3 through -5 will be rebonded.

Engine area vibration data — Spurious high amplitude, low frequency outputs have invalidated much of the vibration and acoustic data obtained during static firings and the S-IC-1 and S-IC-2 flights. This problem is concentrated in the engine area, and is caused by the emitter followers and AC amplifiers being overdriven by excessive piezoelectric transducer outputs. The high transducer outputs are caused by high amplitude, high frequency shocks that are generated by uneven engine combustion. To resolve the problem on S-IC-2 through -5, a change was initiated which removed seventeen engine area vibration transducers that had separately packaged emitter followers and interconnecting coaxial cables, and substituted seventeen transducers that have integral emitter followers with a higher output capability. S-IC-2 flight data indicated that this change considerably reduced, but did not eliminate, the problem. Another change has been initiated to add a capacitor to the AC amplifier input to block low frequency noise signals. This change is effective for all engine measurements on S-IC-3 through -5, and should reduce the high amplitude, low frequency outputs to a level that will not interfere with accurate measurements.

LOX pump inlet pressure measurements - The 60B72091-1 transducer used on the LOX pump inlet high frequency pressure measurements has consistently failed during static tests and flight. These failures are apparently caused by physical shock while the transducer is at LOX temperature. These measurements are important for the detection and evaluation of POGO. To determine the best corrective action for this problem, several new measurements will be made on the S-IC-6 and tested during that stage's static firing. These new measurements include relocation of the subject transducer to a less severe environment, replacement with a prototype of a more rugged design, and determination of the feasibility of using existing measurements for detection of POGO-induced pressure oscillations by increasing the sampling rate.

Fuel filter manifold differential pressure transducers — Investigation of the fuel filter manifold differential pressure transducer bias shift problem revealed that

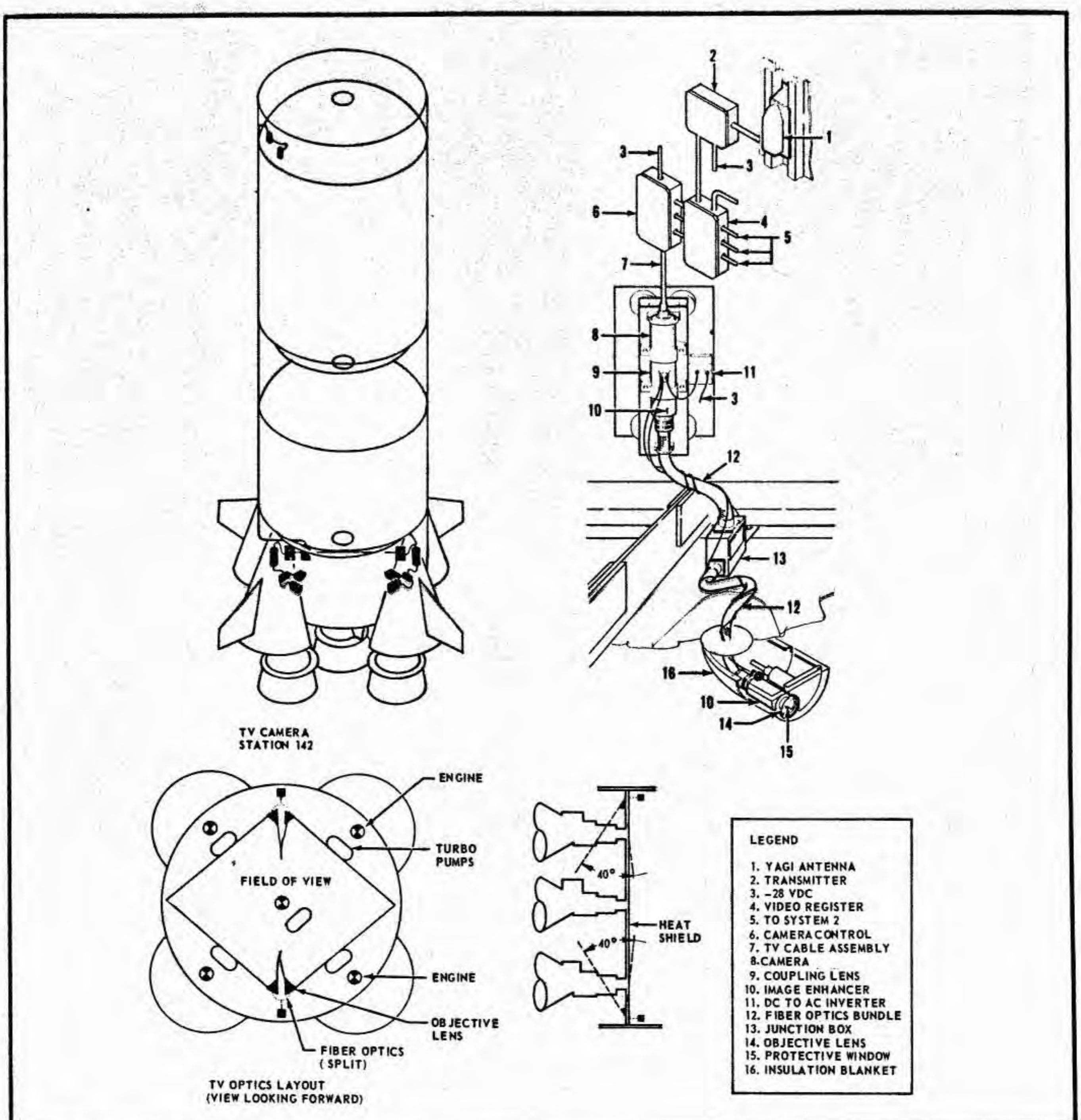


Figure 2-18 S-IC TV System

shifts can be induced in the transducer by prolonged temperature soak at 130°C. However, after 1200 hours of soaking, test transducers showed no decrease in shift rate with time. Extensive studies by the vendor produced design modifications that were thought to eliminate stress in the sensor unit assembly, and thus eliminate the shift problem. Prototypes of the new design, however, showed no improvement. A new design consisting of a single diaphragm with a deposited thin-film strain gage bridge is being investigated. This design would eliminate the need for a reference bellows and silicone oil fill. Also, the new transducer would be of an all-welded construction which would minimize diaphragm stresses. Two prototypes of the new design are being built for evaluation.

LOX and fuel loading system - During S-IC-1 checkout, the loading system "out-of-lock" monitor that is used as an interlock in the propellant tanking computer system (PTCS) operated intermittently. This was caused by the loading electronics being susceptible to stage noise under certain conditions. The problem was corrected by a new design.

During LOX loading at MTF where LOX was loaded to near 100 percent on the loading probe, the LOX overfill sensor intermittently indicated a wet condition. This was attributed to LOX being splashed onto the overfill sensor due to LOX boiling. This problem was corrected by moving the overfill sensor approximately four inches forward.

During the S-IC-1 CDDT, power to the loading system was lost during the power transfer test, upsetting the propellant tanking computer system discretes. This was caused by the loading system being powered from GSE busses that are turned off during the power transfer tests. This problem was corrected by providing uninterrupted power to the loading system.

During this reporting period, a change was released to disconnect the checkout (RACS) cables from the loading electronics for S-IC-1 and -2. This prevented instrumentation test, using the RACS system, from upsetting discretes in the PTCS. A change was also released to provide control of the calibration commands to the loading system from the measuring and RF console in the LCC for S-IC-3 and on.

S-IC TV SYSTEM

The S-IC-2 was the first S-IC flight stage with the TV system installed. The system, which is detailed in Figure 2-18, operated satisfactorily during pre-launch operations and launch.

FILM CAMERA SYSTEM

The S-IC-2 was the first S-IC flight stage with the film camera system installed. The Position I separation camera capsule was the only capsule recovered, but its film was washed out during the first five seconds after separation. It is concluded that this

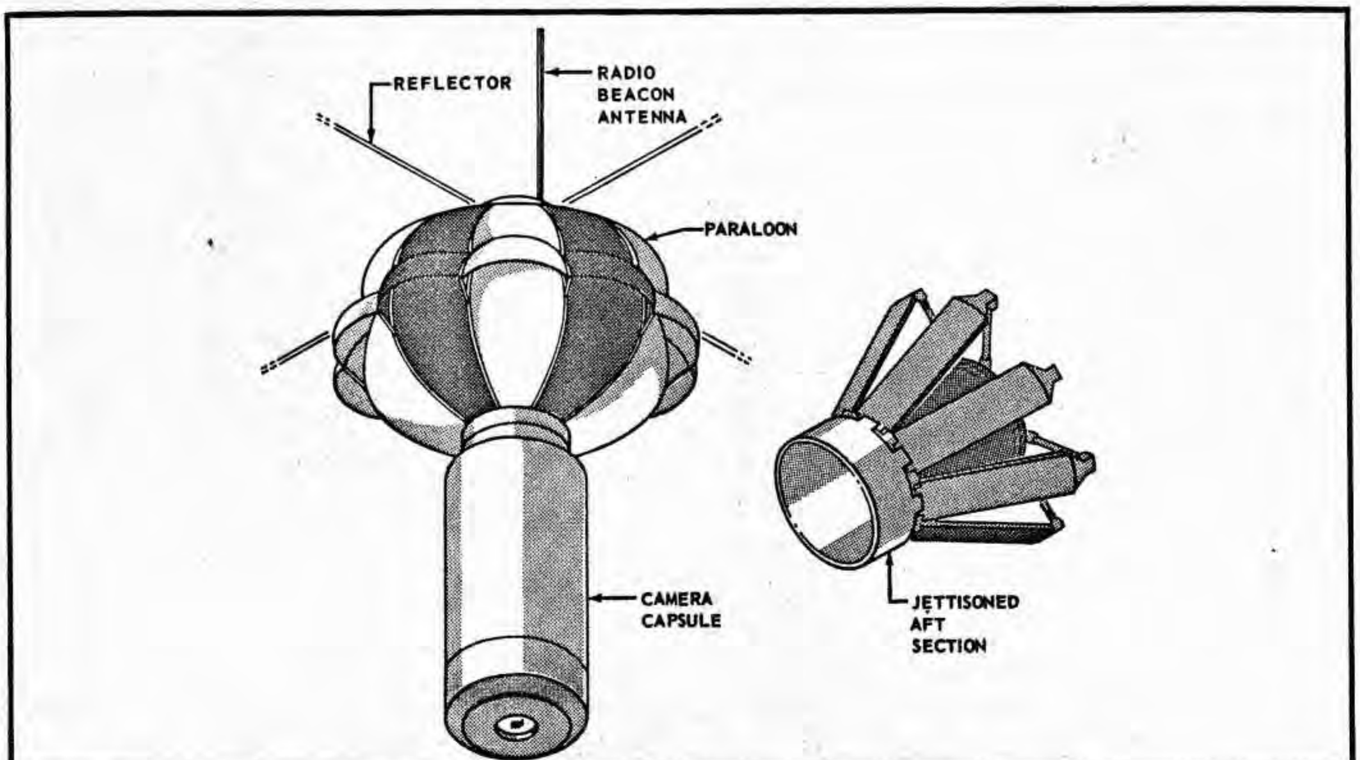


Figure 2-19 S-IC Film Camera Capsule Assembly

was caused by a combination of sun glare and S-II ullage rocket deposits on the quartz protective window. The action necessary to correct this problem will be accomplished on the S-IC-3 and subsequent stages. The three camera capsules, that were not recovered, apparently were not ejected. Excessive temperature and pressure environments immediately following separation are suspected to have caused failure of the camera ejection pressurization system. The exact cause of this failure is still being investigated, and changes being incorporated to prevent its recurrence on S-IC-3 are:

a) Change exposed pneumatic tubing from aluminum to stainless steel;

b) Add orifices to prevent pneumatic line ruptures from bleeding down the ejection bottles;

c) Add thermal insulation to exposed protective cover cables;

d) Modify the GSE regulator system such that the ejection bottle can be pressurized to a higher pressure;

e) Add orifices to prevent pneumatic line ruptures from bleeding down the ejection bottles;

f) Add thermal insulation to exposed protective cover cables; and

g) Modify the GSE Regulator System such that the ejection bottle can be pressurized to a higher pressure.

Figure 2-19 illustrates the Camera Capsule Assembly.

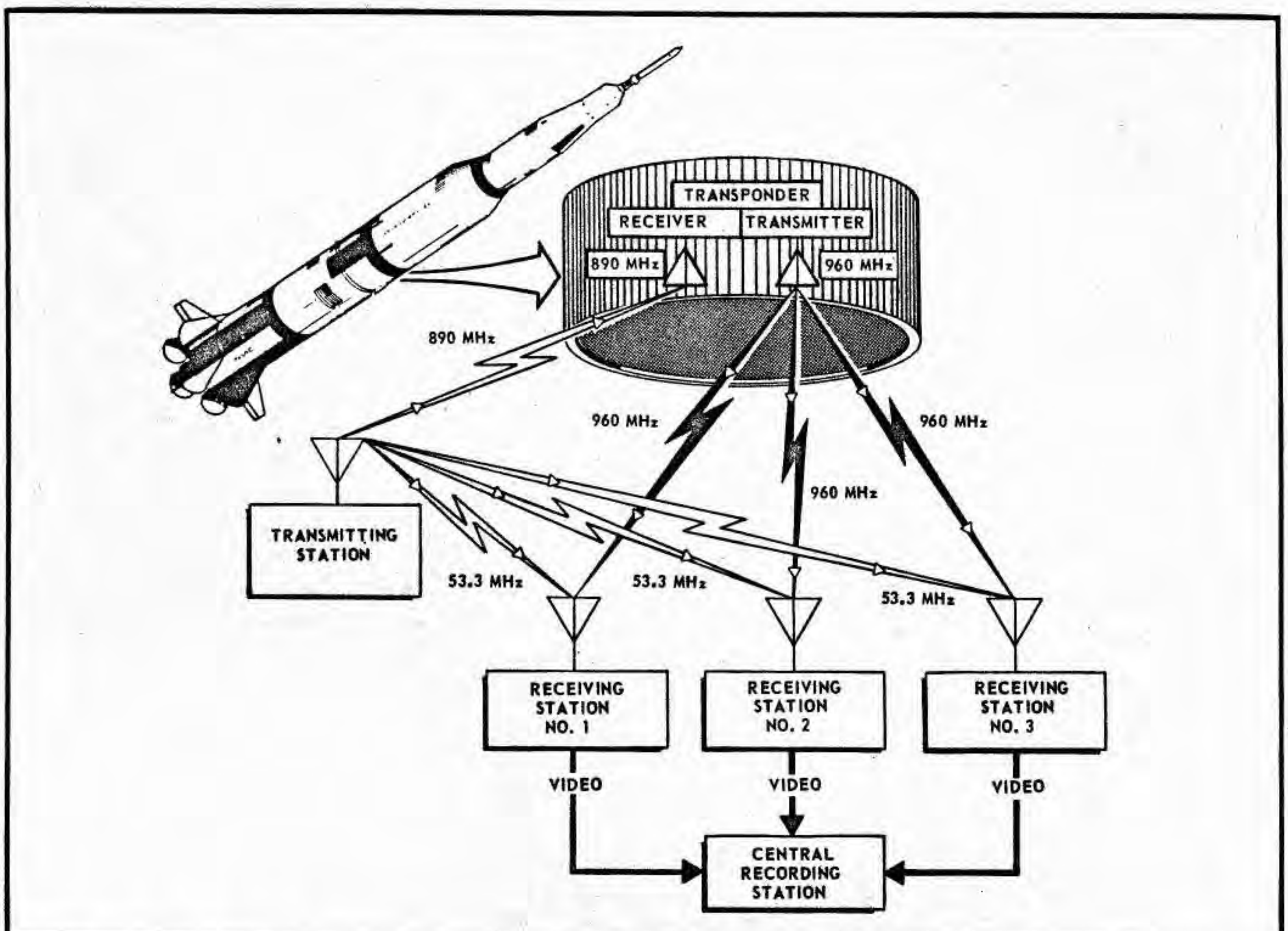


Figure 2-20 S-IC ODOP System

TELEMETRY SYSTEMS

DC-DC converter and DC power isolator - DC-DC converter (60B76123) and DC power isolator (60B76503) failures, due to incompatible production procedures, caused a redesign of the assemblies to provide more reliable components. Also, NASA disapproved the qualification of the assemblies because of the undervoltage rated capacitors used in the vendor design.

Remote digital sub-multiplexer (RDSM) - During a simulated flight test on the S-IC-2 at KSC, a loss of synchronization occurred on the pulse code modulation (PCM) telemetry link. The cause was traced to a remote digital sub-multiplexer (RDSM) output word containing nine logic "zeros" and one logic "one," while the preceding word contained ten logic "ones." Under these conditions, the RDSM output caused the digital gate card in the PCM/DDAS assembly to trigger erroneously and inject an incorrect bit into the 30 bit PCM synchronization pattern. Duplication of the problem in the Boeing electronics laboratory indicated that the problem was due to cable capacitance between the RDSM and PCM/DDAS assemblies. A new digital gate card, with input capacitors that masked the effect of the cable capacitance, was incorporated on S-IC-2 and subsequent stages. This change was not required on S-IC-1 because of the RDSM measurement profile.

Offset Doppler (ODOP) Transponder - Boeing has been unable to verify qualification of the Offset Doppler (ODOP) Transponder to the Contract End Item Specification for the S-IC. However, sufficient data was provided on the range safety decoder, and Boeing concurs that the decoder is qualified for the S-IC stage. Figure 2-20 illustrates the ODOP system.

GSE/MSE DESIGN

S-IC PNEUMATIC EQUIPMENT

S-IC pneumatic console - MTF - The LOX dome purge maximum lock-up requirement has been increased to 1200 psig and the lock-up pressure recorded from the S-IC-5 static firing was within this limit. A change was also processed to put the low purge on an orificed by-pass circuit to reduce the service time on the regulator.

Analysis of S-IC-T static firing data indicated a potential pressure overshoot problem on low fuel prepressurization when the fuel tank is at minimum ullage. This pressure overshoot could cause the stage fuel tank relief valves to cycle. Therefore, a change has been processed to assure that the stage relief valve will not be actuated under normal conditions.

The high failure rate of the helium bottle fill regulator has been corrected. Analysis of S-IC-4 and -5 static firing data indicated a potential pressure overshoot problem on LOX prepressurization. Also, calculations based on the static firing and launch data indicated a potential pressure undershoot problem on fuel prepressurization during engine startup. A change was processed to correct these problems prior to S-IC-3 launch. This change will be verified during the S-IC-6 static firing.

S-IC pneumatic console - KSC - All systems met launch mission rules requirements for S-IC-1 and S-IC-2 launches. Subsequent to each launch, one piece of equipment (forward umbilical service) was found slightly damaged due to severe launch environments. Problem areas which became evident during the processing of S-IC-1, and S-IC-2 are:

a) A rupture of the GHe Primary Regulator diaphragm would result in loss of LOX bubbling capability and therefore jeopardize the stage. A change was processed to add redundant capability and was incorporated prior to launch.

b) Position of hand ball valves needed more positive control to preclude position change during vibration and allow easy monitoring of valve position. A change that provides position indication and locking was processed to rectify this problem.

c) A considerable number of failures occurred in Pneumatic Console solenoid valves. An extensive failure analysis program was conducted in cooperation with the vendor and it was determined that serious seat deformation was occurring when valves were energized for extended periods of time under high pressure conditions. A development program was then initiated to determine the best possible material to resist the seat deformation and meet sealing requirements. Necessary changes have been made and the valves have passed a rigid qualification test.

d) Numerous problems were experienced with the primary module Ladewig pilot operated relief valves during qualification testing for S-IC-1 certification. Redesign of the valves was undertaken and accomplished prior to S-IC-1 launch. Life cycle testing at Boeing/Michoud was successful. The new valve configuration uses a pilot valve separated from the main valve body by flexible hoses to correct a vibration sensitivity problem with the original integral pilot mounting.

e) Two regulator failures occurred in the LOX dome purge module during CDDT activities for S-IC-2. The failure effects were identical, but the failure causes were not. The first regulator apparently failed due to operating the module with the inlet manual isolation valve instead of the LCC control. The second regulator had the same low outlet pressure but had misaligned poppet guide bores that resulted in abnormal wear. A change that provides for incorporation of redundancy, and deletes the failed regulator has been processed.

f) Mathematical models were constructed to simulate components, specifically valves and regulators, in the pneumatic console, thereby facilitating prediction of in-flight operation of these components. Results compared favorably with test data. In addition, studies were made on the necessity of adjusting pipe sizes at the inlet to the pneumatic console to retard the introduction of facility contamination. Research has continued on filtered flow restrictors designed to reduce contamination while still regulating fluid flow.

S-IC pneumatic checkout racks - KSC - Tests conducted using the mechanical automation breadboard (MAB) indicated that the pneumatic checkout racks (PCR) as presently designed are not capable of meeting the customer accuracy requirements for checkout of the S-IC stage LOX, fuel, and thrust OK calips switches. This problem is twofold; first, the ramp rates for pressurization/depressurization of calips systems are too high, resulting in excessive pressure change; and, second, the pressure transducers cannot be calibrated to the required accuracy of $\pm$ .05 percent full scale due to operation of the transducers at 165°F. An engineering change will be processed to eliminate the problems outlined above.

GSE/MSE TRANSPORTATION AND HANDLING EQUIPMENT

S-IC stage handling equipment - Michoud VAB - Numerous rejections against the forward handling ring and the forward lifting linkage assembly brought out the fact that major inconsistencies existed within the subsystems of the S-IC stage handling equipment. At that time, design, maintenance, proof load, and inspection requirement responsibilities were divided between Engineering, Operations, and Facilities for various segments of the total handling equipment.

Boeing Engineering was directed, on may 27, 1967 to accept responsibility for the forward lifting linkage assembly and the rotational brace assembly for the Michoud VAB. A production revision record was then established which, (1) provided a new forward lifting linkage assembly, (2) modified the forward handling ring test fixture to proof test the new forward lifting linkage assembly, (3) modified the existing rotational brace assembly, and (4) modified the existing adjustment linkage assembly. This equipment was used for the first time during lowering operations of the S-IC-10 in the Michoud VAB.

S-IC storage racks - The storage racks that were secured to the LUT during the launch of AS-501 were damaged and their contents, including the bulkhead protection equipment, were partially destroyed. It was apparent from inspection of the launch damage that the racks had been subjected to a more severe environment than the environment furnished as design criteria.

An interim change was established to reinforce the rack structural integrity and to provide additional holes for venting the inside of the racks to outside pressures. However, incorporation of this change could not be made to support the AS-502 launch and the launch caused even more damage to the storage racks than AS-501. Damage to the bulkhead protection equipment was eliminated for S-IC-2 since the equipment was relocated from the storage racks to a room in the base of the LUT prior to launch. Subsequent to S-IC-2 launch, the interim change was revised to provide additional vent holes and structural reinforcement on several of the LUT level 60 racks. These modifications constitute an interim fix based primarily on launch damage experienced during the first two launches. The fix is planned for installation prior to S-IC-3 launch.

The major problem in redesigning the storage racks has been in defining the actual launch environment. Adequate data to define the environment has not been gathered because requests that the GSE equipment and/or the adjacent LUT structure be suitably instrumented to collect data to define the actual launch environment have been rejected. Final redesign of the storage racks to sustain actual launch environments is being held pending definition of the launch environment.

Intertank umbilical reconnect assembly

(a) The intertank umbilical reconnect assembly contains a switch that provides a signal indicating that carrier retraction has been completed. The signal is used to initiate retraction of the swing arm, and its failure can cause mission abort. MSFC requested that a change be submitted to incorporate a redundant "Carrier Retracted" signal source. This was done, the design qualified by test, and the change was incorporated on the LUT 1 intertank umbilical reconnect assembly prior to the S-IC-1 launch. This design change will also be incorporated prior to the launch of all subsequent stages.

(b) A failure analysis of the intertank umbilical reconnect locking mechanism, which had failed at KSC during swing-arm tests, disclosed a design deficiency in that an adverse accumulation of manufacturing tolerances could cause breakage of internal parts. Breakage results in the malfunction of the locking mechanism, and prevents a reconnection of the carrier to the S-IC stage. Design corrective action for the locking mechanism to support the S-IC-1 launch resulted in an interim fix, which could be incorporated by rework of existing components. Rework was necessary to support the launch without impacting the schedule. The corrective action taken for stages S-IC-2 and on resulted in a design to prevent recurrence of the failure.

(c) The Boeing Company initiated a change for the redesign of the intertank umbilical to include backup capability for the retract system. This change resulted from a failure mode and effect analysis and revealed that single point failures could prevent umbilical retraction. Also, a request for change action has been initiated by S-IC liaison at BATC requesting that the single point failure be eliminated from the retract system. This change has been approved with additional directions to eliminate single point failure modes in the retract and reconnect systems.

d) During the extension of swing arm number 1 at KSC, following the S-IC-2 overall swing arm test, the intertank umbilical inadvertently became unlatched from the retracted position. The event went unnoticed during the remainder of arm extension and as the swing arm approached full extension, the umbilical struck the stage. Minor damage, requiring no repair, was experienced by the stage, but the umbilical LOX lines were damaged to the extent that partial replacement was required. Subsequent investigation revealed that the ability of the latch to hold the umbilical in the retracted position under shock conditions was marginal. Therefore a change was initiated which provided a redesigned latch to prevent a recurrence of the problem.

Forward umbilical carrier problem at KSC on S-IC-2—Two valve-type umbilical couplings on the S-IC forward umbilical ground carrier did not mate properly with the flight-half couplings. This resulted in partial closure of the valves within the couplings and restricted flow. Indications were that hardware nonconformance (currently undefined) prevented the ground carrier from fully contacting the vehicle plate. The problem with the couplings was corrected by a change that installed a spacer behind the ground-half couplings thereby assuring that the internal valves are fully open. With MSFC and KSC concurrence, S-IC liaison generated a change, that called for replacement of the poppet valve couplings with straight-through couplings on S-IC-3. The straight-through couplings should eliminate any problem of flow and lock-up pressure associated with the forward umbilical service unit. However, with the bowed condition of the forward umbilical flight plate, shimming of the straight-through couplings may be required to prevent leakage at the coupling seal. The closure problem of the coupling valves will not occur on S-IC-4 and subsequent stages because couplings used on the forward umbilical for these stages are not susceptible to this problem. However, the basic cause of the problem, improper umbilical carrier mating, is still under investigation.

MISSISSIPPI TEST FACILITY

S-IC-5 static firing — While preparing for the S-IC-5 static firing the stage fuel emergency drain duct collapsed during the fuel loading portion of the propellant load test. Investigation revealed that a negative pressure of as much as 12 psig was being developed in the facility RP-1 fill and drain system by a recirculating procedure that was being used for cleaning purposes. Although the same procedure had been used on previous stages (S-IC-T and S-IC-4) the condition was not detected because these stages were equipped with heavy-walled (.060") drain ducts. The wall thickness of the S-IC-5 duct was only .032". After additional investigation and experimentation, the tanking procedure was revised to eliminate the recirculation mode, a nitrogen pressurization system was installed in the facility RP-1 lines, and the lines were instrumented to give a continuous readout of system pressures.

During the second propellant load test of the S-IC-5 the LOX tank ullage pressure was observed to go negative about 0.3 psig for a few seconds after two-line LOX bubbling was initiated. This negative pressure was produced when the ullage volume was suddenly chilled by LOX geysering into the tank from one or more of the partially filled suction ducts. The tanking procedure was changed to close the vents and pressurize the LOX tank to 3 to 4 psig before start of bubbling. This procedure was used successfully on firing day. However, the auxiliary vent had to be cycled 38 times in maintaining the ullage pressure between 3 and 4 psig. Experimentation is under way at MSFC (S-IC-T at R-TEST) to devise a procedure that will suppress geysering without the necessity for cycling the vents.

Valve position indications from the pneumatic console were lost momentarily four times during the S-IC-5 static firing. A post-firing examination disclosed no broken wires or loose connections in the power circuits, and a change was initiated to provide a redundant path for indicating power to the pneumatic consoles at MTF and KSC.

Direct Support KSC

a) An engineer from Michoud has been on site at KSC to provide direct coordination between Boeing Schedule I (Test Requirements) and Schedule III (Test Procedures). This work involves assisting in the review of approximately 150 test procedures per stage, the resolution of comments from Michoud and KSC on approximately 50 test procedures per stage, and the preparation of the detailed audit of test procedure compliance with test requirements. This support will be provided to KSC as long as it effectively contributes to the S-IC stage program.

b) Technical support was also provided during the prelaunch tests and during the actual launch countdown of AS-501 and -502. This support was provided through participation in a team stationed in the central instrumentation facility at KSC and through a team stationed in the Huntsville operations support center at MSFC. For the CDDT and launch of the AS-501 and -502, continuous support during the final 24 hours of countdown was provided for KSC from Michoud.

Preoperational safety review — An S-IC preoperational safety review for the S-IC-1 was conducted at KSC during the period July 5 through August 11, 1967. The review team consisted of members from Boeing, General Electric, International Business Machines, and Rocketdyne. Test procedures affecting the S-IC stage were reviewed against safety criteria that were developed to determine whether or not unsafe conditions could occur as a result of executing the procedures. A total of 159 test procedures were reviewed, resulting in 119 safety problems reports. All 119 have been closed out.

KSC test requirements coordination — Revision E to "Specifications and Criteria for S-IC Stage Prelaunch Checkout and Launch Operation at KSC" (D5-13618) was released during FY 1968. This revision incorporated committed changes and MSFC comments. The majority of these comments concern level of detail and the addition of primary requirements for tests being conducted in excess of the existing requirements. These comments were discussed with MSFC on December 19, 1967, and The Boeing Company agreed to make many of the changes to encourage a more uniform MSFC acceptance of document D5-13618 as KSC test requirements.

AS-501 and -502 GSE launch damage — As a result of the launch environment, some GSE items on the mobile launcher were damaged. The following table is a brief assessment of this damage:

		S-IC-1	S-IC-2
a)	S-IC pneumatic console	Valve manifold assembly damaged	No damage
b)	Pneumatic checkout racks	No damage	No damage
c)	Prevalve accumulators	No damage	No damage
d)	Aft umbilicals	Major damage	No damage
e)	Intertank umbilical	Minor damage	Control box panel missing
f)	Forward umbilical	Minor damage	No damage

g)	Access equipment storage boxes		
	1) Forward skirt	Minor damage	Minor damage
	2) Intertank	Minor damage	Minor damage
	3) Thrust structure	No damage	No damage
h)	Heat shield storage	No damage	No damage
i)	Thrust structure vertical internal access equipment storage racks	No damage	No damage
j)	Forward skirt internal access equipment storage racks	Moderate damage	Moderate damage
k)	Fuel tank upper bulkhead protection equipment storage racks	Racks heavily damaged	Totally destroyed
l)	LOX tank upper bulkhead protection equipment storage racks	Racks heavily damaged	Racks heavily damaged
m)	Intertank vertical internal access equipment storage racks	Heavily damaged	Totally destroyed

A damage assessment for the S-IC umbilical equipment that supported the S-IC-1 launch was accomplished. The three AFT umbilical carriers sustained major damage resulting from the failure of the tail service mast protective doors. The intertank reconnect assembly and the forward umbilical carrier sustained only minor damage. A change was initiated as a result of this assessment. This change provided additional fasteners for the intertank reconnect assembly control box covers to prevent the covers from becoming detached as the result of vibration.

A preliminary assessment of the damage sustained by the S-IC umbilical equipment during the AS-502 launch was conducted. The three Aft umbilical carriers sustained no visual damage and appeared to be adequately protected by the redesigned blast shields that were added to the tail service masts following the AS-501 launch. The intertank umbilical reconnect assembly sustained moderate damage resulting from heat and vibration, but there was no major structural damage. The forward umbilical carrier sustained no apparent damage.

A detailed analysis of this damage is contained in document D5-13842, "Mobile Launcher No. 1 GSE Damage Assessment and Corrective Action Recommendations," for the AS-501 launch and the follow-on document, D5-13842-1, for the AS-502 S-IC-2 launch.

ENGINEERING TEST PROGRAMS

During FY 1968 test activities were directed toward the completion of the reliability program, qualification program, and resolution of design data problems and discrepancies identified during manufacturing, static firing, and S-IC-1 and S-IC-2 launch support operations.

At the beginning of the reporting period, Engineering Laboratories had 59 tests on hand. During the year, 355 tests were received, and 331 were completed. Testing is divided into categories of reliability, qualification, and development testing, and failure analysis.

The High Pressure Test Facility, which experienced approximately five months of down time due to a high pressure line failure, resumed operations in August, 1967. To minimize the impact of the loss of the facility, six tests were conducted at the adjacent Michoud/Chrysler laboratory facilities.

RELIABILITY TEST PROGRAM

The reliability test program began the report period with six tests scheduled for a December 6, 1967, completion date. During that period, four tests were received, one was cancelled, one was reopened, and nine were completed.

Reliability tests completed during FY 1968 include:

- R401 - Pressure relief switch
- R415 - Redesigned outboard engine GOX line assemblies
- R427 - Engine purge system regulator
- R212 - Thrust OK distributor

R409 - Valve-to-tunnel GOX duct assembly
R465 - Redesigned GOX feeder duct
R402 - Upper hot helium supply duct
R411 - Inboard GOX line assembly
R413 - Upper outboard GOX duct assembly

QUALIFICATION TEST PROGRAM

During the reporting period, qualification testing for 220 components was successfully completed, increasing the number of certified components by 208 from 1103 to 1311. Sixty components remain to be certified (see Figure 2-21).

All S-IC-1 and S-IC-2 stage and stage-peculiar GSE hardware was qualified prior to launch, and all S-IC-3 stage and stage-peculiar GSE will be qualified prior to launch.

At the beginning of this reporting period, the engineering laboratories had eleven qualification tests on hand scheduled for completion during December, 1967. During the period, sixteen additional tests were received, one was cancelled, and nineteen were completed, leaving seven tests to be completed. Also, the piece parts qualification test, P24 (quality assurance inspection of MBR37496-9 and MBR37496-10 relays), is an open end item with lots tested on a periodic basis as they are delivered.

DEVELOPMENT TEST PROGRAM

During FY 1968, 208 Development Tests were initiated, and 213 were completed.

Engineering Laboratories supported the AS-501

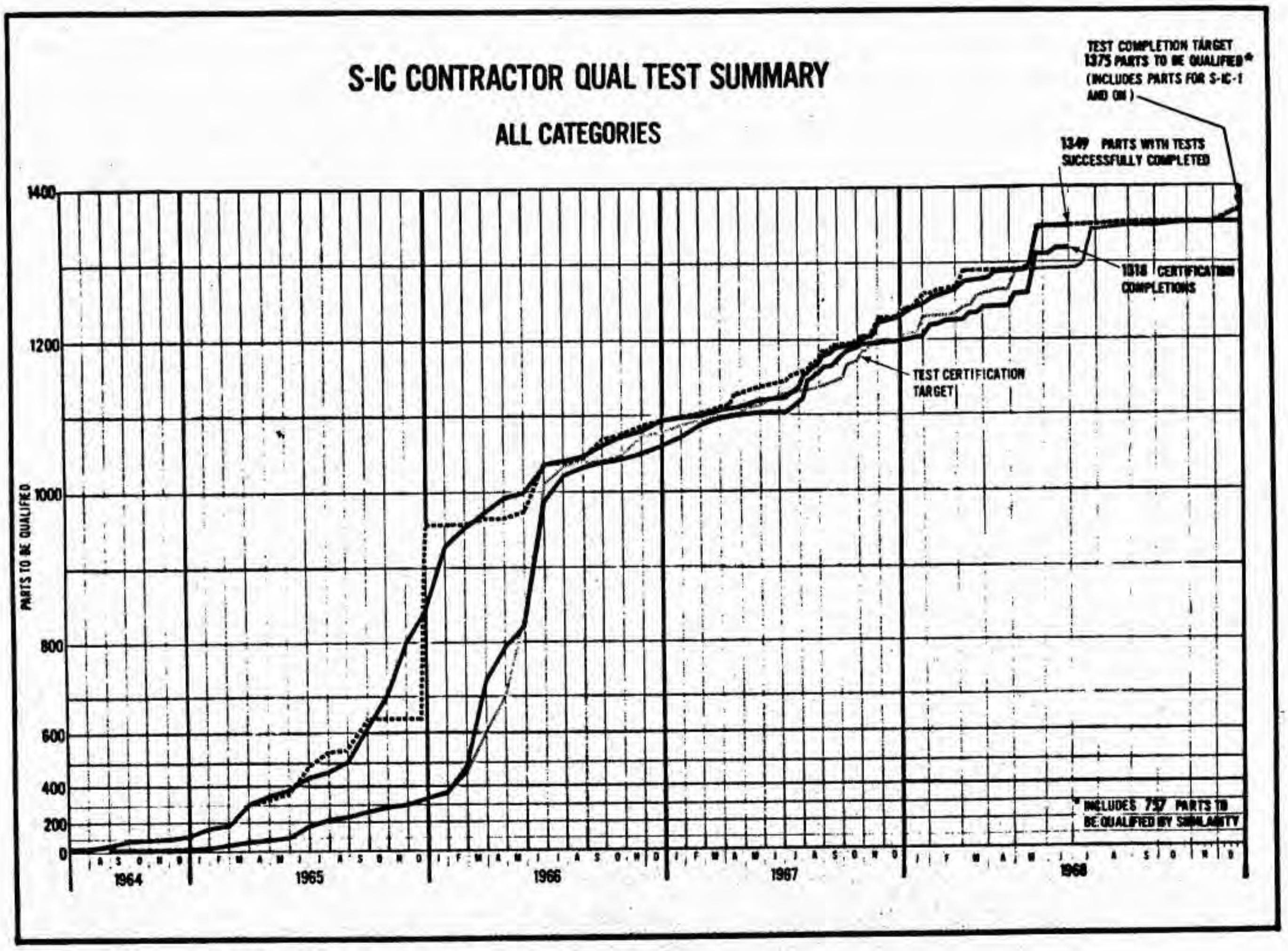


Figure 2-21 S-IC Qualification Test Summary

launch by conducting three development tests. Five development tests were conducted in support of the AS-502 launch.

Subsequent to the S-IC-2 launch, Engineering Laboratories also participated in the search for cause and solutions of problems encountered during the flight of AS-502.

During FY 1968 twenty-eight development tests that led to design changes were conducted. Eight development tests that deal with current problems were in progress at the end of the reporting period.

FAILURE ANALYSIS TEST PROGRAM

During the fiscal year 90 failure analysis tests were completed.

INVESTIGATION OF DEEP-FLAW EFFECT IN S-IC TANKAGE

Problems on the S-II stage focused attention on all S-IC stage pressure vessels that are proof-tested at room temperatures and are used at cryogenic temperatures. The problem involves the fracture toughness of tank material in the presence of a deep surface flaw. A fracture toughness test program has been initiated in Seattle to investigate the deep-flaw effect in 2219 aluminum with a scheduled completion date of July 1968. Previously, an evaluation of all S-IC pressure vessels had been conducted by the structural development unit in Seattle. Based on existing data, the S-IC propellant proof tests were found to be adequate. Results of the current test program are expected to verify this evaluation.

S-IC SYSTEMS AND STUDIES

STAGE SAFETY STUDY

The stage safety study was conducted for S-IC-2 through S-IC-15 stages, at MSFC's request, to determine whether the stages would be safe at KSC for a seven-day period during which RP-1 fuel is onboard, stage electrical power off, and GSE electrical power on or off. "Safe" was considered to be a condition that would assure no physical or functional damage to stage systems or subsystems. Damage was considered to have occurred if the design limits, tolerances, or specifications of a stage, system, or subsystem were exceeded. The study indicates that the S-IC Stages are "safe" when certain conditions exist as defined in the study.

S-IC ENGINEERING SYSTEM SAFETY PLAN

Safety Engineering is preparing an, "S-IC Engineering Safety Plan" which will develop and implement a system that identifies relevant goals, requirements, controls, procedures, responsibilities, methods of accomplishment, and schedules for systems safety engineering. A preliminary copy of this plan was reviewed and commented on by affected organizations, and the estimated final release date is July 1, 1968.

SPECIFICATION COMPLIANCE STUDY

All S-IC requirements necessary to assure astronaut safety, stage integrity, and achieve end conditions of flight have been designated as "Man-Rating Requirements", and will be verified as completed through an S-IC-3 specification compliance study. The S-IC contract end item specifications and Saturn interface control documents have been reviewed and all applicable man-rating requirements identified. Documented verification of compliance is being established by reviewing engineering and test documentation to assure that the identified requirements have been met. This study will be published as document D5-13874, "Specification Compliance Study for S-IC-3," which is scheduled for release on June 28, 1968.

S-IC STAGE DAMAGE PREVENTION STUDY

Document D5-13704, "S-IC Stage Damage Prevention Study," was completed on April 12, 1968, and is currently being released. This document presents the results of a study that was performed to establish and recommend dispositions of ground support equipment failures that could cause S-IC stage damage at MTF. The original findings were based on the S-IC-4 configuration. A formal "Fault Tree Analysis" was used to identify areas of concern. One hundred twenty-one potential hazard areas have been identified of which 93 have been satisfactorily resolved with the remaining 28 still under study. A follow-on study to update the findings for the S-IC-6 configuration is in progress and will be documented prior to static firing.

S-IC STAGE STORAGE

S-IC stage storage requirements have been prepared and forwarded to MSFC for approval. MSFC standards 492 and 500, giving S-IC stage storage specifications, were received as information from MSFC, and have been reviewed. In several areas, these standards are more stringent than the Boeing prepared requirements. Major differences are in the area of ambient humidity, maintenance of contaminant levels and restriction of particulate material, and, in general, cover long storage periods. The final approved requirements for storage will become part of the CEI Specification Part II.

FLIGHT EVALUATION PROGRAM

S-IC-1 Flight

a) Flight Evaluation Preparations

In preparation for the S-IC-1 flight, a complete practice run was accomplished using the S-IC-3 static firing telemetry data as the data bank. The practice run provided a successful verification of our capability to reduce, process, and analyze the S-IC-1 flight data. Also, a complete set of flight predictions were calculated and documented. These predictions were used to provide a rapid assessment of the S-IC-1 flight performance by identifying measurements that were significantly different from those anticipated.

b) Flight Evaluation

The S-IC-1 launch occurred at 7:00:01 a.m., EST, on November 9, 1967. The Boeing flight evaluation team participated in three presentation meetings which reviewed the flight data. The required twenty-one day report was submitted to MSFC as scheduled, on December 5, 1967.

Generally, the AS-501 flight met all mission objectives except as specified in the Boeing Sixty Day Report, document T5-7000-1, which was released as scheduled on January 11, 1968. The report evaluated the performance of the first flight of the S-IC stage.

S-IC-2 Flight

a) Flight Evaluation Preparations

Preparation for the S-IC-2 flight included such activities as certification of the basic data processing program using S-IC-2 flight readiness test data as input and verification of the stage telemetry configuration.

Standard basic processing analysis program work was completed on schedule. As a result of problems encountered on the S-IC-1 flight, several basic processing program modifications were incorporated, and PERT charts were released in about one half the time required for the S-IC-1 flight. Data handling team interface review meetings were held to strengthen the overall communication network between the various flight evaluation organizations.

Test data requirements for analysis of the AS-502 CDDT, countdown, and launch were compiled and coordinated with the MSFC Mission Operations Office and MSFC Computation Laboratory. Inputs were made for inclusion in the NASA program support requirements document and the MSFC processed data requirements document. Attempts were made to obtain installation of additional instrumentation at KSC for measurements of the launch environment and its effect on the GSE. This was not successful for the AS-502 launch, but efforts are continuing for the S-IC-3 launch.

The flight prediction document, was released on March 11, 1968. This document listed the predictions for S-IC-2 flight measurements.

b) Flight Evaluation

S-IC-2 post-flight activities, including the reduction and processing of the raw telemetry data, followed the PERT plan as closely as possible. The PERT completion times of some items were not met due to late delivery of data tapes from MSFC, and special analysis of the POGO problem, which impacted the entire processing effort.

Data from the TEL 4 ground receiving station was used as the primary source for the PAM and FM data until the POGO problem became evident. A 2 cps "wow and flutter" error was found in this data, and the Central Instrumentation Facility ground receiving station data was used.

Processing charts were released daily as a tracking method for the flight processing. These charts were released through L+14 days as required.

All Boeing contractual data deliveries were completed on or before the required delivery dates. The S-IC-2 data quality and delivery schedule was generally better than that for the S-IC-1 launch.

As a result of personnel training after the S-IC-1 flight and improved activity scheduling, the number of aperture cards made for the S-IC-2 flight was reduced by 33 per cent from the S-IC-1 flight.

As a result of a problem encountered in the PCM data from the S-IC-2, a new formatting technique for PCM data was designed.

The L+1, L+8, and L+14 day presentation material for the S-IC-2 flight were delivered on schedule to the MSFC flight evaluation working group (FEWG) chairman. The Boeing L+21 day input to the FEWG AS-502 report was submitted as scheduled on May 9, 1968. The L+60 day report T5-7000-2 was released, as scheduled, on June 28, 1968.

17-7 PH. STAINLESS STEEL USAGE SURVEY

A Boeing survey is being conducted to determine all 17-7 PH steel parts used on the S-IC stage that are reliability critical per document D5-11910. Fifty-four parts made from this alloy were found. These parts are used in components listed in this document. A matrix of the processors and processing used in fabrication of these parts is in preparation.

CONTRACT END ITEM (CEI) SPECIFICATIONS

The Part II S-IC CEI Specification, S-IC-3 through S-IC-10, has been prepared and is currently being reviewed by NASA. This specification will be incorporated into CPIF Contract NAS8-5608, Schedule I, subsequent to negotiation and NASA approval, and when it is approved, will serve as the basis for configuration definition and acceptance testing of Stages S-IC-3 through S-IC-10.

The S-IC-4 was delivered to the Customer at Michoud with one government and two contractor CEI nonconformances for which no corrective action was required. Of these nonconformances, eleven MSFC and twenty-four contractor qualified electrical components failed to fully achieve electromagnetic interference test requirements under MIL-I-618D. Also, voltage fluctuations (transients) in excess of the end item test plan limits ($\pm$ 14 volts) appeared at one of the monitored electrical circuit points during power application and removal sequences.

During the fiscal year, a waiver procedure was established to cover nonconformances, evidenced prior to launch, that are dispositioned "use-as-is." The procedure requires both NASA and Boeing technical and contract signatures to validate the waiver. All waivers are then documented in the appropriate Part I CEI Specification subsequent to vehicle launch. Ten S-IC-2 waivers were processed, approved, and incorporated into the Part I CEI Specification using this procedure.

INTERFACE CONTROL DOCUMENTATION (ICD) AND INTERFACE REVISION NOTICE (IRN)

STATUS OF BASIC ICD'S

As of May 16, 1968, there were forty-five basic ICD's applicable to the S-IC stage, of which thirty-three are applicable to the stage hardware, eleven are applicable to the GSE, and one is common to both stage and GSE. All ICD's are identified in the May 1, 1968, issue of MA-004-002-2H, "Saturn V/S-IC Interface Control Documentation Contractual Index and Status Report."

Of the forty-five basic ICD's applicable to the S-IC stage and associated GSE, forty-one were officially accepted by Boeing, three have not been received, and one is not acceptable at this time. The three ICD's not received are flight sequence programs for AS-508, -509, and -510. The ICD not acceptable to Boeing is the interface between the LUT and the S-IC access and bulkhead protection equipment storage racks. An administrative change proposal, which defines the changes required for compatibility with S-IC stage documentation, has been submitted to NASA.

On August 8, 1967, Boeing initiated the use of record ECP's for the purpose of contractually accepting ICD/IRN's if they are compatible with S-IC Stage and GSE hardware and documentation. Record ECP's R-0001 through R-0073 have been submitted to MSFC through May 16, 1968.

RELIABILITY ENGINEERING

RELIABILITY ANALYSIS

Documents D5-12572-1, "S-IC System Design Analysis - Propulsion/Mechanical," and D5-12572-2, "S-IC System Design Analysis - Electrical/Electronics," were each updated twice during this reporting period. These updates reflected failure mode and effect analysis, both propulsion/mechanical and electrical/electronics, for S-IC-3 and -4.

Other important S-IC reliability documents that were released during the reporting period, and the purpose for the release, are:

a) Document D5-11910, "Saturn S-IC Reliability Status Report." — Two updates were made, one to add additional status on reliability program elements, and one to add S-IC-4 stage release.

b) Document D5-11954-1, "Saturn S-IC Stage Reliability Analysis Record." — Updated twice during FY 1968 to report predicted and assessed reliability for S-IC-3 and -4.

c) Document D5-13693, "Hydrogen Explosion Hazard Survey." — Updated twice to report that no ignition source is present in the interstage area that is sufficient to detonate an assumed hydrogen atmosphere.

d) Document D5-11954, "Saturn S-IC Stage Reliability Assessment and Prediction Program." — Revised once during the year. This document contains the methodology used to apportion reliability goals and describes in detail, the Saturn S-IC reliability information system.

e) Document D5-12789, "Design Analysis for S-IC Malfunction Detection System." — Updated once to reflect release of S-IC-4. This document contains the necessary analyses and data from which the S-IC design requirements for a malfunction detection system may be determined.

RELIABILITY ASSESSMENT

Failure Analysis

Continuous emphasis has been placed on the S-IC Failure Analysis program. A total of eighty-two failure analysis test were completed during the reporting period. Operating procedures were revised during FY 1968 to improve processing and analysis of failed hardware.

In addition to monitoring receiving and subassembly discrepancies, major emphasis has continued on monitoring and evaluating in-service failures that occur on stage and GSE hardware during post-manufacturing checkout, static firing, and post-static checkout and after delivery to KSC.

In addition to tracking <u>each</u> in-service failure in the weekly "Failure Status Summary" (unresolved failures) for program corrective action, the Michoud Reliability Data Center has initiated a "Top Priority" report for each scheduled launch. This report includes only those failures that could impact launch. If program corrective action cannot be implemented prior to the launch, the problem is submitted to the Boeing/Michoud UER/CER Assessment Board for launch impact assessment. This "board" is chaired by the S-IC Chief Engineer with representatives from Boeing Quality and Reliability Assurance (Q&RA), and Product Assurance.

Equipment Quality Analysis

The equipment quality analysis effort was expanded during FY 1968. This was the result of increased emphasis on product quality initiated in 1967. Emphasis has been placed on the analysis of reliability critical components. Additionally, this area has been expanded to provide the quality maintenance testing required by contract change order MICH-723. This combination of equipment quality analysis and quality maintenance testing constitutes an ambitious schedule of in-depth testing and analysis of "critical" hardware. During the fiscal year, 111 Equipment Quality Analyses and six Quality Maintenance Tests were performed. A summary of this activity follows:

a) Number of EQA's performed, during FY 1968.......................... 111

b) Number of EQA's performed and closed.............................. 92

   1) With no anomalies.................. 51
   2) With anomalies resulting in :

      Design Change 5
      Process Change................ 5
      Quality Control Improvement 31

   NOTE: Some EQA's resulted in more than one type of change.

c) Number of EQA's performed remaining open 19

d) All QMT's performed are open.

e) Number of hardware problem analyses performed FY 1968 138

f) Number of discrepancy checks issued FY 1968................................ 39

Data Collection and Analysis

During FY 1968, 525 special computer printouts concerning failure data were supplied to requesting organizations by the Launch Systems Branch Reliability Data Center. These special printouts were required to support such varied activities as product assurance, human engineering, and logistics.

A total of 789 Boeing Investigation and Corrective Action Requests (BICAR's) were initiated by the Launch Systems Branch or assigned to Boeing by NASA during FY 1968. Seven hundred thirty-five of these were closed, and 54 remain open and are programmed for completion and closeout during the first quarter of FY 1969.

Continuous effort is being expended to isolate repetitive failure trends. Some of these collective analyses have resulted in further laboratory analysis and/or design corrective action. The requests for design corrective action are included in the BICAR statistics above.

A total of 84 NASA "ALERTS" (problems experienced by other NASA centers and contractors) were received and evaluated for S-IC impact during FY 1968. Seventy-five were closed; nine remain open.

Reliability Audits

The results of the FY 1968 reliability audits of compliance with the reliability requirements as defined by D5-11013, "Reliability Program Plan," and related documentation have been published for the first three quarters of FY 1968. These three quarterly "Reliability Program Status" reports were D5-13747-3, D5-13747-4, and D5-13757-1. The "Reliability Program Status" report for the fourth quarter FY 1968 will be published after the end of the fourth quarter and will be designated D5-13757-2.

Product Quality Survey

Work continued on the "Product Quality Survey" during this report period. This survey, which was initiated during FY 1967, reviews and updates existing GSE failure mode and effect analyses. This updating covers hardware and time intervals not previously analyzed, identifies single failures that could cause abort, and identifies single failures that could cause loss of stage vehicle or crew.

As a part of the product quality survey, an in-depth review was made of all S-IC stage piece parts and standards. This review was conducted by Engineering, Quality and Reliability Assurance, and Operations. The review included analysis of specifications, qualification, receiving inspection, functional test, vendor surveillance, and failure history. As a result of the review, recommendations were made for strengthening product quality of piece parts and standards. These recommendations resulted in tighter receiving inspection, increased vendor surveillance, and increased equipment quality analysis activity. Also, an engineering review board recommended action on 34 critical piece parts for either new specifications, revised specifications, or higher level of qualification. Those recommendations were approved by the S-IC Chief Engineer and are in process of being implemented.

Reliability Analysis Model

Work continued during this report period in support of the reliability analysis model. This model delineates ground rules for providing S-IC stage reliability data to MSFC as an input into the MSFC Level II Reliability Analysis Model (RAM). Failure effect analysis loadsheets, non-critical cables lists, criticality determination loadsheets, symbolic block diagrams, and engineering critical components lists for S-IC-3 and S-IC-4 have been completed and transmitted to MSFC.

Failure Management by UCR Task Force and Assessment Board

During FY 1967, a task force was established to assure that all Unplanned Event Records (UER) and Unsatisfactory Condition Reports (UCR) were properly dispositioned, failure analyses completed, program corrective actions taken, and flight readiness actions specified prior to the AS-501 flight. Major functions performed were:

a) Classification of all S-IC program failures by their criticality as assessed in relation to S-IC-1 launch effect;

b) Establishment and implementation of a workable failure and failed hardware activity tracking system; and

c) Support to the UER/UCR Assessment Board, which was established based on the task force finding that program corrective actions could not be completed on all failures in time to meet the launch date.

Assessment Board members were the S-IC Chief Engineer, Q&RA representative, Product Assurance manager, and the UCR task force manager.

The Assessment Board reviewed all unresolved failures and evaluated the risk each might have on the AS-501 launch and flight to assess Boeing's S-IC flight readiness position.

Reliability Program Presentations

The monthly S-IC reliability program status was presented to MSFC on February 19, March 18, and April 16, 1968. The general outline of these presentations is as follows:

a) Activities of reliability and coordination committee;
b) Summarize ECP's initiated, changed, or stopped because of reliability activities;
c) Summary of ECP's reviewed by reliability organizations;
d) Failure reporting and correction action;
e) Human factors;
f) FM&EA's, reliability predictions and assessments;
g) Reliability test;
h) Parts program activity;
i) Materials and processes activity;
j) Boeing selected areas from 65-18 history approach, philosophy; and
k) Significant changes in program or organization.

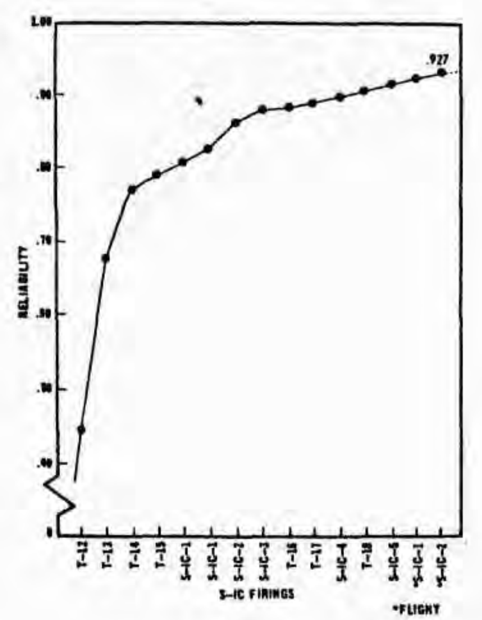


Figure 2-22 Growth of Assessed Reliability-S-IC Stage

Since July 1967, the reliability coordination committee has held bi-monthly meetings to implement corrective actions required to eliminate S-IC reliability deficiencies, all of these actions were completed by December 29, 1967. Two NASA/Boeing meetings concerning reliability program deficiencies and planned corrective actions were held August 31, 1967 and September 5, 1967. These meetings presented The Boeing Company's position and planning to implement an effective S-IC reliability program. Another meeting was held on December 7, 1967 to report the status of the S-IC reliability program and discuss associated problems.

Growth of Assessed Reliability for S-IC

Figure 2-22 depicts the growth of assessed reliability for the S-IC stage.

MANUFACTURING DEVELOPMENT

The Manufacturing Development organization, a part of the Boeing/Michoud Operations organization, supports manufacturing in all areas necessary for the production of S-IC stages. This organization works closely with Engineering Design and other technological groups, and maintains constant surveillance on new trends in materials, design, and techniques that are applicable to the Boeing/Michoud S-IC program.

WELD DEVELOPMENT

TANK SKIN TEE STIFFENER CRACKS

At Michoud Engineering's request, a weld repair program was devised to repair tee stiffener web cracks. Since minimum heating in skin membrane was desired, the following heat sink methods were employed on simulated repair weld panels: copper chill blocks were placed adjacent to the manual Tungsten Inert Gas (TIG) repair on one side of the skin membrane, and dry ice was held in place on the opposite side of the skin membrane. As a result, heat-affected membrane areas of the simulated repair weld did not exceed 300°F, and this repair procedure was adopted in lieu of riveted doublers for future tee stiffener crack repairs.

GOX DUCT LINE MODIFICATION

Manufacturing Development was requested by Michoud Engineering to assist in high priority prototype weld fabrication of an S-IC GOX line duct. This work involved manual GTA (Gas Tungsten Arc) welding of A-286 alloy with Hastelloy W filler wire and was initiated after reliability tests (static pressure plus induced vibratory stress) resulted in fillet weld failures. Engineering redesigned the GOX duct line by deleting four fillet welded gussets and replacing them with an attachment flange with 100 percent penetration single vee weld joints. Fabrication of needed weld tooling and establishment of welding sequence was then undertaken by Manufacturing Development. Upon completion of this redesign, reliability testing established acceptability of the redesigned assembly.

SATURN S-IC REPAIR WELD HISTORY

Repair welding at Michoud is monitored by the Manufacturing Development organization. Records of repair weld frequency include the S-IC-15 stage. Figure 2-23 is a data plot, which includes 1968 repair weld frequency. Accumulative percentage of required repair welds through March 1968 was 0.605 percent. This compares favorably with the March 1967 average of 0.614 percent.

DIAPHRAGM TEST HARDWARE

As a part of Boeing's company-sponsored activities at Michoud, two flat bulkhead tank assemblies were completed this year in support of Boeing/Huntsville Engineering. Fabrication of these tanks was part of a program initiated by Huntsville to determine the feasibility of replacing forward S-IC bulkheads with flat diaphragm bulkheads.

MACHINING AND FORMING

ELECTROMAGNETIC COIL REPOTTING AND MANUFACTURING FACILITY ESTABLISHMENT STUDY

During the reporting period, a repotting procedure, including tooling, was established for repairing or building new 4-1/2-inch diameter electromagnetic coils that are used with the high-energy capacitor discharge unit to correct contour distortions on the S-IC. Damage occurs to these coils when part of the polyurethane potting compound separates from the coil or when a dielectric breakdown of the pot-

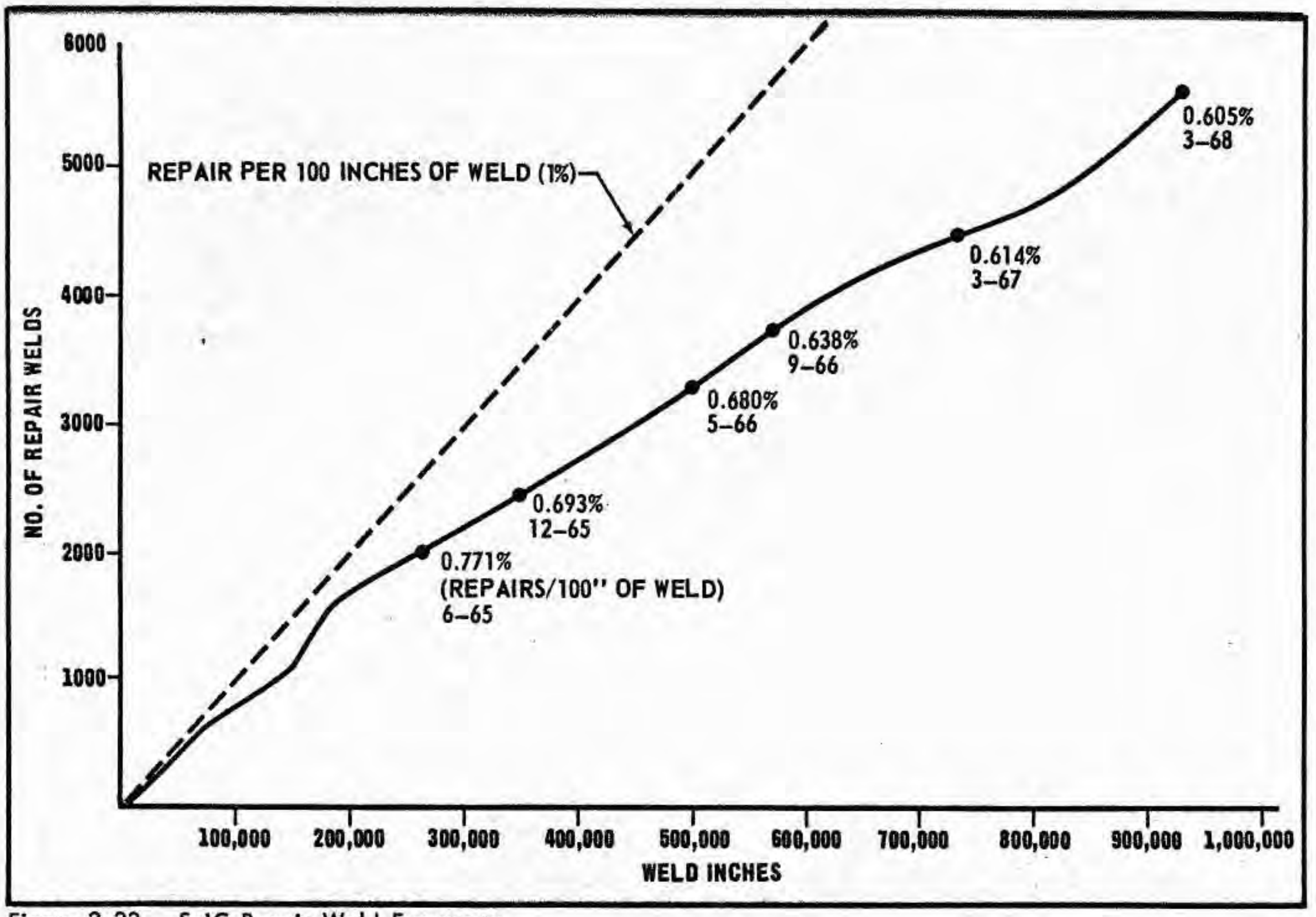


Figure 2-23 S-IC Repair Weld Frequency

ting occurs. In the past, damaged forming coils were sent to another facility to be repaired. This usually took about three months. It is now possible to repair a damaged coil at Michoud in five days. It is also possible to produce new coils to alleviate the present shortage and to evaluate coil efficiency for various designs.

STRESS RELIEF WITH VIBRELIEF MACHINE

An evaluation was made of sonic vibration for stress relieving metal parts warped by machining, welding, or heat treating. This was done to find a method for expediting the flattening of base heat-shield panels warped during test firing of the S-IC-4 stage so that these panels could be used on the S-IC-8. Tests conducted using a Vibrelief machine manufactured by Lodding Engineering Corporation were unsuccessful; therefore, sonic vibration for stress relieving metal parts of the S-IC vehicle is not considered practical at this time. Further research on this method is necessary to expand its potential for future production use.

DIFFUSION BONDING CAPABILITIES AT BOEING/MICHOUD

The growing importance of diffusion bonded assemblies in aerospace applications prompted a study of limitations and capabilities within the Boeing/ Michoud facility. One of the objectives of this study is the development of a sub-scale facility in which various concepts relative to the production of a true diffusion bonded assembly may be evaluated. Successful solid-state diffusion bonding of Ti-6A1-4V (titanium alloy) to itself has been achieved with little difficulty. Solid-state bonding of 6061 aluminum to itself has also been achieved with the use of a copper interleaf. Efforts are continuing to diffusion bond aluminum to itself without the use of an interleaf. As a part of this effort, an evaluation is being made of a process by which component specimens are protected from atmospheric contamination by being totally immersed in a cleaning solution at each stage of the cleaning process. While still immersed in the final cleaning solution, the components are transferred to a vacuum chamber within the furnace. This chamber, containing the same solution, is then sealed, pumped out, and back-filled with argon. Diffusion bonding then takes place in this argon atmosphere.

ORBITAL TUBE FLARING MACHINE

In an attempt to explore improved methods of closely controlling flare configurations having extremely close tolerance requirements, an orbital flaring concept developed by NASA/MSFC was evaluated. This concept, which utilized a cone and die cartridge assembly may alleviate the misalignment problem encountered with the conventional Leonard 3CP machines. Its use will possibly enable certification of only one machine capable of using varying tube sizes.

CHEMICAL PROCESSES

AIR POLLUTION CONTROL

Many Boeing suppliers are located in Los Angeles County, California, where air pollution control regulations have been put into effect. Since there is a trend toward increased legislation regulating permissible contamination, Manufacturing Development is conducting a survey of current control regulations and legislation. Boeing/Seattle has already found it necessary to modify one process specification to meet Los Angeles County requirements. Possible replacement processes for Boeing specifications that do not meet Los Angeles County air pollution standards are being investigated.

HIGH TEMPERATURE RESIN FOR ELECTROMAGNETIC FORMING COIL ENCAPSULATION

Several materials have been examined for electromagnetic forming coil encapsulation. Criteria for evaluation included high-impact strength, high-temperature stability, and a hardness comparable to cured polyurethane resin, the material that is used to pot coils for ambient use. Representative formulations of the following three different types of material have been selected for further development: a temperature-resistant epoxy resin, a high-strength silicone rubber, and a high-temperature-resistant polyaromatic.

EVALUATION OF ZINC PAINT COATINGS FOR STEEL TABLES IN VAB

A zinc paint coating was applied to one section of a steel turntable in the VAB and was found to resist the corrosion that normally occurs. Plans have been made to apply this coating to the three turntables in the VAB. This will result in a labor cost savings.

ADVANCED FIBROUS COMPOSITES

Advanced fibrous composites comprise a new materials field in which a plastic or metal matrix is reinforced with advanced filaments, such as boron, in lieu of normal glass fibers. The result is a high-strength, high-stiffness, low-weight material with major structural applications. Fabrication data and experience on a laboratory basis is being gained for possible use in stages beyond the S-IC-5. Tensile and flexural test panels of boron filaments in an epoxy matrix have been fabricated and tested, and continued evaluation is planned for combined boron filament/glass composites where advantage can be taken of the high strength of boron filaments and the low cost of fiberglass.

ELECTRICAL/ELECTRONICS

SHEET PLASTIC MOLDS FOR ELECTRICAL CABLES

During the reporting period, a technique was developed for polyethylene molds to be produced for use in electrical cable production. A .04-inch thick polyethylene molding material is used since it is semi-transparent, semi-ridged, is easily trimmed, and requires no mold release. The molds are made on a commercial RAY-VAC vacuum-form machine, which has a 24 by 24-inch capacity. The sheet polyethylene, while hot, is formed over a die by pulling a vacuum under the mandrel. Significant savings can be realized by using sheet plastic molds since they can be reproduced at the rate of one per minute on the RAY-VAC machine.

IMPROVED MANUFACTURING TECHNIQUES

During FY 1968, Boeing/Michoud worked with tool suppliers to develop many improved manufacturing techniques. These techniques have been documented in Boeing Operations experience retention documents dealing with the following subjects:

a) "Portable and Perishable Tools;"
b) "Cryogenic Hardware Processing;"
c) "Machine Shop Modernization;" and
d) "Weld Fabrication of Large 2219 Aluminum S-IC Booster Components."

In relation to the above mentioned improved manufacturing techniques, Boeing/Michoud developed a presentation that points out how American industry as a whole has benefited from the improved techniques developed. This presentation was made to the Subcommittee on NASA Oversight, Committee on Science and Astronautics, U. S. House of Representatives, and to key personnel at MSFC.

QUALITY ASSURANCE

PROGRAM DEVELOPMENT

SYSTEMS

During this reporting period a product analysis function was established in the source control group. As a result, undesirable trends, potential problem areas, and deficiencies, can now be detected by review and evaluation of Equipment Quality Analysis (EQA) reports, Unplanned Event Records (UER's), failure/defect data, receiving inspection reports, laboratory reports, and other pertinent data, and action as necessary will be initiated to correct the same.

A mechanized priority system was implemented in the mechanized procurement system during FY 1968. The receiving inspection daily status report now displays status and estimated completion dates for each priority item.

A new "Work Plan" format for source surveillance and inspection has been completed. A source coordinator visited all field locations for the purpose of conducting an indoctrination course of the new plan.

NASA representatives in the receiving inspection area audited the receival of gases during the month of August 1967. Recommended actions were made to require that each receipt be chemically tested for all attributes of the procurement specification or have the vendor supply certified test data. Purchase orders were changed to require that certified test data be furnished with each receipt.

A revised system for planning inspections of government furnished equipment has been put into effect. A detailed inspection record replaced the previous "blanket" planning.

A receiving inspection/source control work plan has been developed that provides for unified and coordinated inspection effort from release of purchase order until delivery of hardware to the production store.

A review of the piece part inspection plans and failure rejection history was conducted during the fiscal year. The aim of this review was to reduce inspection when possible to do so without compromising the quality of the end product. The end result of this review was that inspection was reduced on certain parts, increased on some, and remained the same on others.

The computerized Q&RA configuration accountability system was implemented during the redelivery of S-IC-3 and was proven to be fully operational during the redelivery of the S-IC-4. This system is a series of interrelated computer programs that mechanize the configuration evaluation and accounting systems. It will be implemented at KSC for S-IC-4 and on.

MTF Q&RA was reorganized during FY 1968 to form a Quality Engineering support section in addition to the existing test inspection and configuration accountability sections. This reorganization provides overall quality program coverage for the MTF portion of the S-IC program.

MTF Q&RA initiated the development of a computerized tab run system which provides an automatic recap system for all tests, a daily status report, and a work scheduling report. The tab run is a daily updated listing of all open, planned and unplanned, paper listed by location, milestone, and test event prerequisites. This system has resulted in an estimated savings of $84,000 annually at MTF.

A facilities inspection plan was established by MTF Q&RA for inspection of preventive maintenance accomplished on all critical systems where Q&RA is required to control functional configuration or cleanliness level. Planning for all facilities work is being reviewed by Q&RA for quality requirements. The MTF Q&RA organization also initiated a program of periodic inspection and preventive maintenance of government furnished property not formerly included in the preventive maintenance program.

TECHNIQUES

The development and documentation of nondestructive testing techniques continued during the reporting period. Techniques developed that further enhance our ability to verify the integrity of S-IC components are:

a) Eddy current thickness measurement of nonmetallic coating;

b) Ultrasonic measurement of metal thickness from one side ;

c) Eddy current techniques for identifying B-nuts of different tempers;

d) Eddy current inspection for detecting surface cracks in steel spherical bearings and housings;

e) Eddy current technique for detecting surface cracks in nonmetallic ablative coating;

f) A system to provide visual and audible alarm at a remote location of the presence of a fuel leak;

g) A system with an automatic tube feed that inspects lengths of aluminum tubing for rejectable surface defects with a visual and audible alarm;

h) A new method of preparing mounts of titanium fasteners has been developed and implemented. The new method provides for mounting the fasteners in full section and then surface grinding, instead of splitting, on the cutoff machine. This provides a much superior specimen, with no cutting burns, which was very difficult to obtain previously; and

i) A new test fixture was developed in the physical test laboratory to do torque and tensile tests on nut plates and other self-locking fasteners. The fixture reduces setup time and improves testing capabilities.

The development of nondestructive testing techniques is continuing. At the present time, the following techniques are under investigation and development:

a) Crack detection in drilled holes - objective is to develop an ultrasonic technique and portable instrument to rapidly detect cracks in the sides of drilled holes with ultrasonic surface waves;

b) Comparison of nondestructive test methods for weld inspection - objective to compare the capabilities of visual, X-ray, eddy current, and ultrasonics to detect defects in welds using actual defects as determined by destructive inspection as the standard;

c) Soldering capability of printed circuit (PC) board - objective is to develop an eddy current technique and instrument to determine the capability of PC boards to produce an acceptable solder connection;

d) Surface roughness measurements - objective to develop an eddy current technique and portable instrument to rapidly measure surface roughness of machined surfaces;

e) Crack propagation detection - objective to develop an ultrasonic technique (acoustic emission) to detect the propagation of cracks in metals. Particularly directed toward long-term stress corrosion crack generation in stored structures;

f) Weld penetration monitoring - objective to develop an infrared technique that measured the depth of weld penetration during welding process;

g) Penetrant capabilities - objective to compare the capabilities of selected penetrants to detect surface cracks in metal; and

h) Ultrasonic hand scanner - objective to evaluate the performance and capabilities of an ultrasonic system utilizing a portable hand scanner for spot weld inspection and other selected applications.

PROCEDURES

The basic technical document for Factory Operations/Test Inspection, D5-11982, "Special Inspection Procedures" is continually being updated and expanded as necessary to reflect changes in hardware. The basic technique document for Factory Operations/Test Inspection, D5-11997, "Quality Technical Instruction", is also being updated and expanded as necessary to reflect the adoption of new techniques as they are developed.

"Sampling Procedures for Fluids and Gases", Document D5-13666, is being rewritten to establish guidelines for all gas and fluid systems at MTF. This rewrite develops the criteria for systems sampling rather than components sampling and provides a single source for fluid cleanliness control. The end result will be the development of a composite Document D5-12855, "Cleaning, Testing and Handling of Oxygen, Fuel and Pneumatic Components", which will include the requirements and control methods to be applied to stage and support facility systems.

Procedures have also been developed during the fiscal year to:

a) Set up criteria for accepted certified vendor test data in lieu of in-house functional testing;

b) Assure compliance to all safety standards during LOX compatibility testing of materials; and

c) Provide a method of obtaining and maintaining a record of corrective actions taken by suppliers on discrepant hardware.

LABORATORY INSPECTION – TOOLS AND EQUIPMENT

Following is a partial listing of tools and equipment that have been obtained and put into use during the reporting period:

a) An additional portable magnetic particle tester was received and certified for receiving inspection nondestructive testing;

b) Two new particle identification kits were received by the quality evaluation laboratories. These kits contain slides of identified contaminants that will aid in the identification of unknown contaminants found in clean environments or on cleaned parts;

c) Two 23 by 70 inch "Mylar Flo" laminar flow benches were received and installed for contamination control and receiving inspection. These benches greatly increase the capabilities of both areas by providing a clean environment for inspecting larger clean parts and a second area for performing particulate contamination analysis;

d) Receiving inspection acquired five additional 10-power lighted inspection glasses to aid in inspection of electrical circuits and other small electrical parts;

e) The metallurgical laboratory received a set of eight electrical conductivity standards ranging from 1.0 percent to 101.2 percent, International Association of Copper Standards (IACS) to be used for the verification of heat treatment of alloy by eddy current method;

f) Receiving inspection has received a Model PT-1033-8 Product-O-Ron for precision measurement of roundness and geometrical relationship. This instrument records measurements on recording discs to an accuracy of $\pm$ 0.0000025"; and

g) A portable vacuum tweezer system unit was received by the quality evaluation laboratories, This unit will enable personnel to collect and separate particles greater than .05" and, when used with the Swinny Hypodermic Adapter, to collect particles less than .05" on 13mm diameter filters for contamination and spectroscopic analysis.

QUALITY ASSURANCE ACTIVITIES

QUALITY ENGINEERING REVIEWS

During the fiscal year, quality engineering reviewed 75 engineering drawings, 330 engineering orders, 52 supplier acceptance test procedures, 330 supplier cleaning documents, and 110 company specifications for compliance with the requirements of IN-I-V-S-IC-65-13. They also participated in six critical design reviews for supplier furnished hardware.

QUALITY AUDITS

Figure 2-24 denotes the quality program audits performed during FY 1968. A total of 55 audits were made. Sixteen of these were inplant, 13 were in special categories, and the remaining 26 were audits of Boeing suppliers. Audits performed resulted in a total of 467 discrepancies. The 26 audits of Boeing suppliers resulted in the identification of 54 system and hardware discrepancies. The noted discrepancies have been resolved, or are in work at this time.

	1967						1968					
INPLANT AUDITS	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
MEASUREMENT CONTROL LAB.	•											•
RELIABILITY AUDITS				•								
SOURCE CONTROL				•								
QUALITY EVALUATION LAB.					•							
RELIABILITY DATA CENTER						•						
STAGE TEST						•						
ENGINEERING ANALYSIS							•					
RECEIVING INSPECTION							•					
STAGE ASSEMBLY AND TOOLING INSP.								•				
MTF								•				
SUB SYSTEMS TEST									•			
EQA										•		
CONTAINERS AND WELDED ASSEMBLIES											•	
ENGINEERING LABORATORY SUPPORT												•
DISCREPANT SPARES SEGREGATION AREA												•
SPECIAL AUDITS												
MRB	•											
UNPLANNED EVENTS RECORDS		•										
SAFETY AUDIT OF HANDLING EQUIPMENT			•									
SPEC. HARDWARE AUDIT FOR KSC			•									
EQUIPMENT CALIBRATION			•									
SAFETY AUDIT OF MOBILE EQUIP. (FAC.)			•									
MOBILE EQUIPMENT			•									
HARDWARE							•					
NASA AREA SURVEYS								•				
TIME/CYCLE SENSITIVE HARDWARE								•				
CONTAMINATION CONTROL AUDIT									•			
MATERIEL										•		
GASEOUS NITROGEN										•		
SUPPLIER AUDITS												
VACCO	•											
BABCOCK	•											
SOUTHWESTERN INDUSTRIES	•											
FUTURECRAFT			•						•			
ACCESSORY PRODUCTS			•									
ITT CANNON			•									
GENERAL ELECTRIC				•								
FILTORS				•								
SPRAGUE ELECTRIC				•								
BOURNS INCORPORATION						•						
STATHAM INSTRUMENTS						•						
RAYTHEON						•						
NAVAN PRODUCTS							•					
PARKER SEAL							•					
GROVE VALVE							•					
DRAGON ENGINEERING								•				
STERER ENGINEERING								•				
AUTOMATION INDUSTRIES									•			
SOLAR									•			
J. C. CARTER									•			
MAROTTA VALVE									•			
PARKER AIRCRAFT										•		
ARROWHEAD										•		
EDC CORPORATION										•		
SYSTRON DONNER										•		

Figure 2-24 Quality Audits

SOURCE EVALUATION AND SURVEILLANCE

The Michoud source control chart room has been expanded into an effective supplier performance and hardware problem analysis function. Supplier performance review charts are maintained that reflect both satisfactory and unsatisfactory supplier performances. This technique provides source control management with the aides necessary to assess manpower requirements and placement, and permits a decrease in source control surveillance of suppliers with continuous satisfactory performance and a concentration of corrective effort on those suppliers with current hardware or system deficiencies.

Nonconformance data is analyzed, categorized, and displayed in the source control chart room in such a manner that impact problems and discrepancy trends are readily recognized. This visibility provides a means of initiating timely corrective action of noted deficiencies, meaningful assessment of representative's performance, and effective product improvement. Product nonconformances are classified into one of four categories; critical hardware failures, noncritical hardware failures, critical hardware defects, and noncritical hardware defects. The number of nonconformances allowed to accumulate against a supplier before initiating positive remedial action depends upon the classification of the deficiency as follows:

Category I - Critical Hardware Failure - One Unit

Category II - Noncritical Hardware Failure - Two Units

Category III - Critical Hardware Defects - Two Units

Category IV - Noncritical Hardware Defects - Three Units

When supplier performance review charts indicate that a supplier is deficient in one or more of the above categories, a product analysis report is generated. This report, which describes the deficiency in detail, is then forwarded to the cognizant source representative and a date by which the representative must ensure that the supplier has taken appropriate corrective and nonrecurrence actions is established. When analysis of a hardware deficiency indicates that previously delivered hardware and/or hardware currently in production could be affected by the same anomaly, the cognizant representative is immediately notified by telephone. The problem is discussed and a decision made relative to withholding acceptance of hardware at the supplier's facility until the problem is resolved. When deficiencies in a product are considered to be of sufficient magnitude to withhold shipment, all affected inhouse materiel and quality control personnel are notified. This notification includes a description of the deficiency and the justification for withholding acceptance. Upon resolution of the reported deficiency, the representative is required to return the product analysis report, containing a complete description of the corrective action taken, to the Source Control office. The stated corrective action is reviewed for adequacy and, if acceptable, retained by the supplier performance review group for future reference. This continual evaluation of supplier performance assures the delivery of high-quality products and provides the necessary management tools for maximum source control effectiveness.

The practice of periodically performing in-depth hardware analyses and quality and process control systems reviews at selected supplier facilities has been formalized under Change Order MICH-723, "Quality Maintenance Program." The purpose of the Quality Maintenance Program is to provide additional confidence that existing hardware will perform as intended and/or qualified, emphasizing critical hardware and hardware with no apparent problems. (A more complete description of the Quality Maintenance Program can be found on page 63 of this document.) A document has been released defining Quality Maintenance Program requirements, selected suppliers, and the tentative schedule for review. As now constituted, source control is responsible for constructing all review plans, scheduling and coordinating review team activities, providing team captains, and assuring that suppliers correct all noted deficiencies. Suppliers selected for review under the Quality Maintenance Program will be reviewed annually throughout the life of their contracts.

The process control function has been realigned. Work plan surveillance is now being maintained at processors in the Southeastern area. The surveillance schedule provides for a minimum of two visits annually to each processor. All process survey and surveillance activity is now being handled through the Michoud source control office.

RECEIVING INSPECTION

The Michoud receiving inspection group inspected and processed 32,539 lots during FY 1968.

QUALITY EVALUATION LABORATORIES

During 1968 major investigations were conducted by the quality evaluation laboratories. Some of these investigations were:

a) An investigation of the possibility of corrosion of the Saturn V fuel tank by microbial contamination found in RP-1 fuel in February 1967 has been completed. No visual evidence of pitting or any form of corrosion were noted on iridite test strips of 2219 and 7075 aluminum alloys.

b) Failure analysis of a cracked nut submitted to the quality evaluation laboratory by KSC determined the failure to be due to stress corrosion cracking. The basic material of the nut is 303 stainless steel. Intergranular corrosion was evident. Susceptibility to such attack is attributed to excessive carbide precipitate at the grain boundaries. Carbon combines with chromium in the steel and may precipitate out as chromium carbide at the grain boundaries during annealing. This apparently occurred, and in so doing it depleted the chromium in the areas near the boundaries and hence made the material susceptible to intergranular attack, as chromium is the main element for resistance to corrosion. A 300 series alloy, such as 304L or 316L, with much lower carbon content that 303 has been discovered to be much less susceptible to attack.

c) Periodic cracking when flaring 1/4 by .035 inch wall 6061-T6 aluminum tubing has been a manufacturing problem for some time. Nearly all such tubing has been procured from Alcoa to MIL-T-7081 specification. Laboratory testing of this tubing has found it to meet the mechanical property and chemical requirements of the procurement specification. Flaring is done to MS33584 drawing. From considerable testing and examining done, regarding this problem, it is apparent that optimum conditions must exist in the tubing (including ideal chemical composition) before it can be consistently flared in the T6 condition. Very slight discontinuities readily become crack initiators. Flaring tests on a sample of recently received similar tubing manufactured by Reynolds found it to flare acceptable. Comparison tests with Alcoa samples showed some difference in chemical composition, though both manufacturers were within specification requirements. Magnesium, for example, was 1.2 percent in the Reynolds tubing and 0.86 percent in Alcoa. Mechanical properties were determined to be essentially the same. General surface condition, though different (mottled on Reynolds and smooth on Alcoa) is not believed to be directly accountable for success or failure in flaring. Further testing is being done but at the present time it appears that chemical composition is a key factor in the resolution of the problem.

PRODUCTION INSPECTION

Incremental in-process inspection co-incident with the build-up of the S-IC stage is continuing. The Quality and Reliability organization is providing support to Engineering for qualification testing, reliability testing and development testing.

QUALITY ASSURANCE ACTIVITIES (MTF)

Quality Engineering Review

During FY 1968, quality engineering reviewed 160 facility maintenance instructions, 39 acceptance test procedures, document D5-11789-100 test procedures, and all operating instructions. The criteria used were conformance to the end item test plan and IN-I-V-S-IC-65-13 requirements, and the incorporation of prerequisites, correct sequence, and safety requirements.

Configuration Accountability

The MTF GSE/MSE configuration definition was established by comparing the engineering "as-designed" and the "as-built" configuration. This configuration assessment establishes the baseline necessary to support the development of modification programs. The "as-built" configuration was used extensively in the review and development of the planned modifications to incorporate the engineering change proposals required to update the S-IC pneumatic console.

S-IC-4 and -5 analysis data showed that Systems A Dynisco Pressure Transducers in use had a high failure rate. Investigation showed that, when the transducers were first received, they were discovered to have an unstable zero. The 150 transducers were returned to the vendor, where some of the potting was removed to allow the compensating network to be rebalanced. Inspection of the failed transducer also showed that the unsupported bridge compensating coil had failed due to metal fatigue. A substitute type of pressure transducer was obtained and put in use.

PRODUCT PERFORMANCE ASSURANCE

The objective of the Product Performance Assurance function at Michoud is to provide increased confidence and assurance to both Boeing Management and NASA that activities critical to the mission or program are identified, planned, and accomplished. The organization reports directly to the Boeing Michoud Manager and assists him in discharging his obligations for successful S-IC stage flights. It is responsible for monitoring and assessing the adequacy of technical disciplines throughout design, production and test, and the integration of these disciplines to ensure total product integrity and stage flight readiness, with supporting data.

During FY 1968, Product Performance Assurance activities were characterized by a continuation of a risk-assessment approach and the promotion of techniques to strengthen disciplines to minimize or eliminate identified risks. Particular emphasis was placed on greater focal-point administration of the three closely related disciplines of system safety, reliability, and quality assurance to provide for increased task selectivity within and among these three disciplines and the implementation of selected tasks in order of assurance effectiveness.

STAGE FLIGHT READINESS ASSESSMENTS

The final AS-501 formal flight readiness assessment of the S-IC-1 stage was conducted during the Apollo Program Director's Flight Readiness Review on October 19, 1967.

The MSFC Saturn V Program Manager's Pre-Flight Review (PMPFR) for the S-IC-2 stage portion of the AS-502 vehicle was held on January 16, 1968. This review was preceded by a similar review at the MSFC Stage Manager's level on January 9, 1968.

The PMPFR presentation consisted of an overall stage contractor and stage manager's assessment, plus a system-by-system review of the stage and its peculiar GSE. The final flight readiness assessment of the S-IC-2 stage was conducted during the Apollo Program Director's Flight Readiness Review on March 11, 1968. On April 4, 1968, the S-IC-2 stage was flown successfully. However, the second and third stages experienced some engine difficulties during the flight necessitating certain changes to the AS-502 mission profile.

Both the AS-501 and AS-502 were unmanned flights. In the last quarter of FY 1968, NASA designated the AS-503 (S-IC-3 stage) as the first manned flight.

Assessments of S-IC stage flight readiness (a Product Assurance activity) are supported and validated through reviews by the Boeing Performance Board and Launch Readiness Board (see page 7), which consists of top management representatives from all Boeing/Saturn Programs. The Manager of Product Performance Assurance serves as Secretary of the Performance Board.

RISK APPRAISAL CYCLE

Work continued during the reporting period on assuring the technical and performance integrity of the S-IC stage by strengthening the means for timely identification of problem sources and dispositions, known as the risk appraisal cycle. Figure 2-25 illustrates the sources of problems and screening processes used to arrive at whether there is any risk to the solution and if so, is the risk acceptable for the next launch or does further action have to be taken before the next launch. This activity is the cornerstone for arriving at stage flight readiness assessments as discussed above.

QUALITY MAINTENANCE ASSURANCE

In February 1967, Boeing/Michoud initiated a program to further assure the quality of vendor hardware, with primary emphasis on that hardware where failure could cause loss of crew or stage (reliability critical hardware).

During FY 1968, this activity was expanded under Change Order MICH-544 issued in July 1967 and Change Order MICH-723 issued in March 1968. The major areas constituting this program are:

a) Michoud management team motivation visits to vendors to re-emphasize the significance of their hardware in successful Saturn V launches;

b) In-depth audit of documentation associated with the engineering and procurement cycle for reliability critical hardware;

c) Physical identification of hardware (and associated documentation) as reliability critical to highlight its unique stature in the function of the stage or GSE;

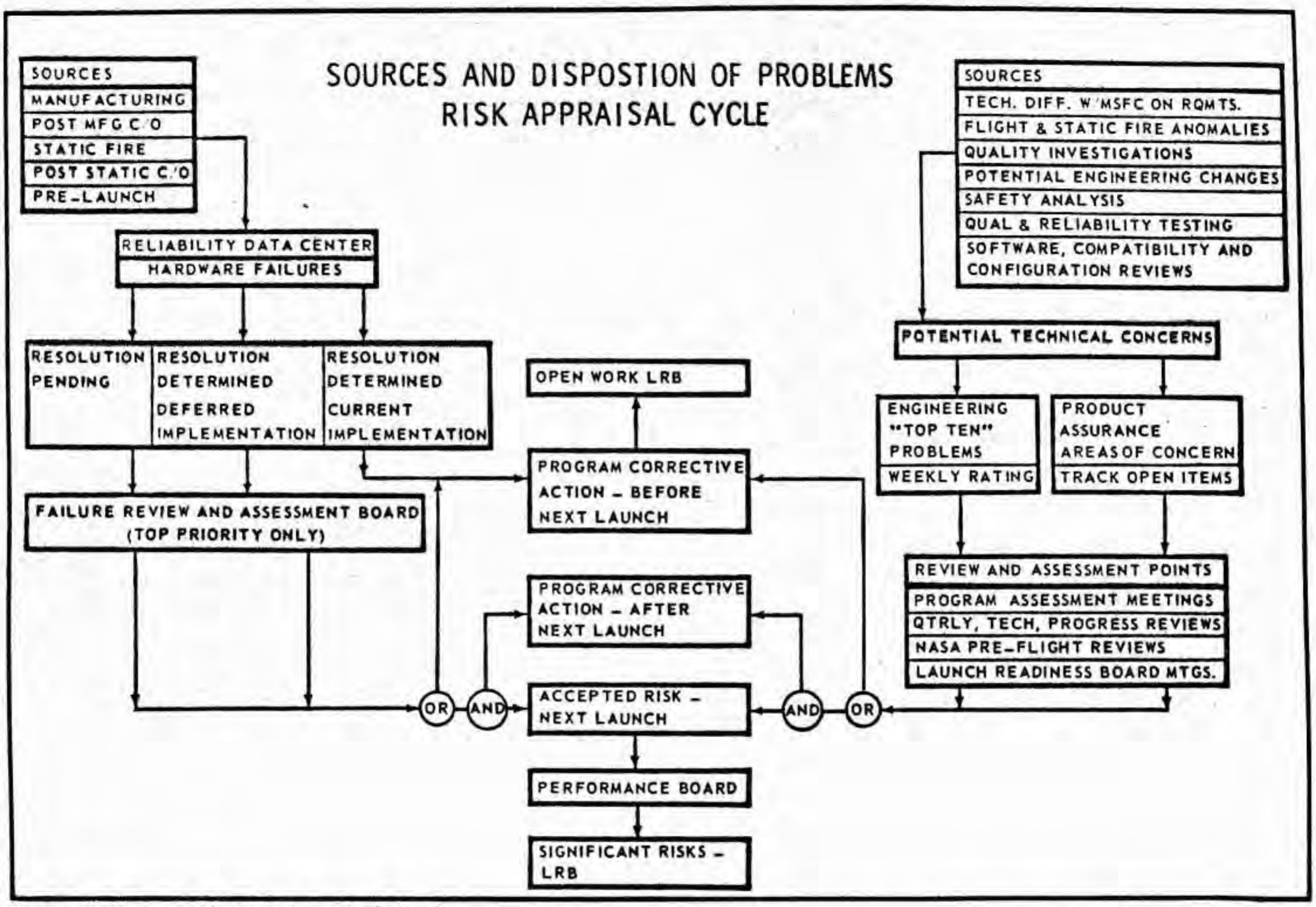


Figure 2-25 S-IC Risk Appraisal Cycle

d) Hardware review at vendors for such disciplines as receiving inspection, processing methods, and quality control standards;

e) Quality hardware analysis of vendor hardware consisting of both destructive and non-destructive testing; and

f) Design confidence tests consisting of selected testing modes to augment and reinforce the qualification test program.

Considerable progress was made during this fiscal year in accomplishing these objectives which are time phased for completion by the end of 1970. Results to date are contributing to increased confidence in total product integrity. Figure 2-26 is illustrative of the visibility given to this effort in the Boeing/Michoud Program Control Center.

FAILURE AND CORRECTIVE ACTION PROGRAM

Continued emphasis was given to the area of hardware failures to further improve the disciplines involved in identifying, evaluating, tracking, and closing out such failures on a timely basis. A closed-loop system was established between Michoud and Boeing Atlantic Test Center to provide for "real-time" visibility on failures. Also, a Failure Review and Assessment Board was created to review, assess, and dispose of those failures impacting the next launch. This board is composed of representatives from Engineering and Product Performance Assurance.

SYSTEM OPERATION AND SAFETY ASSURANCE

An S-IC Integrated Safety Program was established in October of 1967 under the administration of Product

Figure 2-26 S-IC Quality Maintenance Program

Performance Assurance. This program is responsive to Boeing Corporate Policies and NASA requirements. The novel aspect of this program is that it combines and integrates the heretofore separate industrial and system safety into one safety plan and calls for organizational ancillary plans responsive to this master plan.

Product Performance Assurance controls and maintains the master plan, approves the ancillary plans to ensure total safety integration and compatibility, chair the S-IC Safety Board consisting of organizational representatives and provides program direction as recom mended by the Board. This arrangement provides for a single safety focal point for increased management control and improved visibility of safety performance versus assigned tasks. Figure 2-27 illustrates the organizational safety relationships including the composition of the S-IC Safety Board while Figure 2-28 depicts the controlling safety documentation for this integrated safety program.

The S-IC Safety Board is chartered as a management working group to provide the means by which the combined attention of all organizations can be directed toward assuring safety excellence in the S-IC program. The Board meets on a regular basis and provides an effective tool for the integration of organizational activities relating to hazard identification and control. Visibility on these activities is maintained in the Boeing/Michoud Program Control Center.

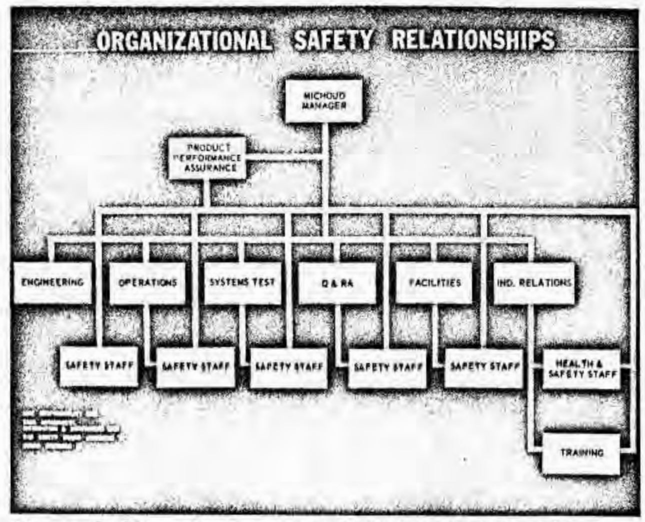


Figure 2-27 Organizational Safety Relationship

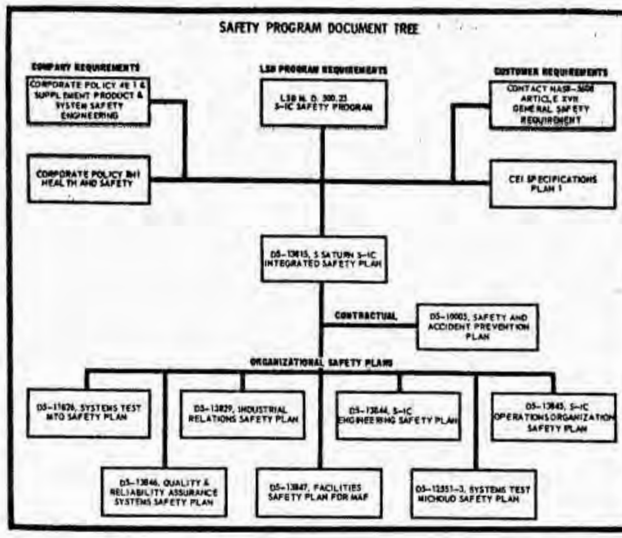


Figure 2-28 Integrated Safety Program Controlling Documentation

The line control safety effort is recognized as a continuing vital element in the master safety plan as is the Line Control Safety Council of line safety directors. This Council, as an adjunct to the S-IC Safety Board, continues to specifically assist line supervision assigned to production, test, and laboratory operations in carrying out their line control responsibilities.

PRE-OPERATIONAL SAFETY REVIEW

During FY 1968, a pre-operational system safety review of the S-IC-1 and -2 was held at KSC to provide for increased safety assurance. This was carried out as part of a total system safety review of the AS-501 and -502 under Program Directives 44 and 44A. The purpose of these directives, as they relate to Boeing Schedule I, is:

a) 44 - Provide correlation of the S-IC-1 configuration baseline and assure that the S-IC-1 launch vehicle, design, hardware, test specifications and criteria, software, and test procedures were consistent and compatible.

b) 44A - Provide assurance that those system elements within Schedule I design and/or operational responsibility are technically accurate, adequate, consistent, and compatible for AS-502 and -503, GSE, and KSC facilities.

MSFC SYSTEM SAFETY NETWORK

The Product Performance Assurance organization provided representation to the MSFC sponsored system safety network for Saturn prime contractors at the three meetings held during the year. The purpose of the network is to promote interchange of information and development of new techniques relating to system safety.

NEW TECHNOLOGY

During 1968, a total of 54 New Technology disclosures were reported from Schedule I. One such item, which should have broad appeal, is a technique for making view graphs very quickly from expendable printed matter, such as magazines. The resulting transparancies may be either in color or black and white.

DELIVERABLE DATA

Data submitted during FY 1968, in compliance with the requirements of Contract NAS8-5608 (Schedules I & IA), are included in Appendix D. Delivery of these items was in accordance with requirements set forth in Document IN-I-V-S-IC-67-10, "S-IC Program Deliverable Data."

TECHNICAL SUPPORT DATA

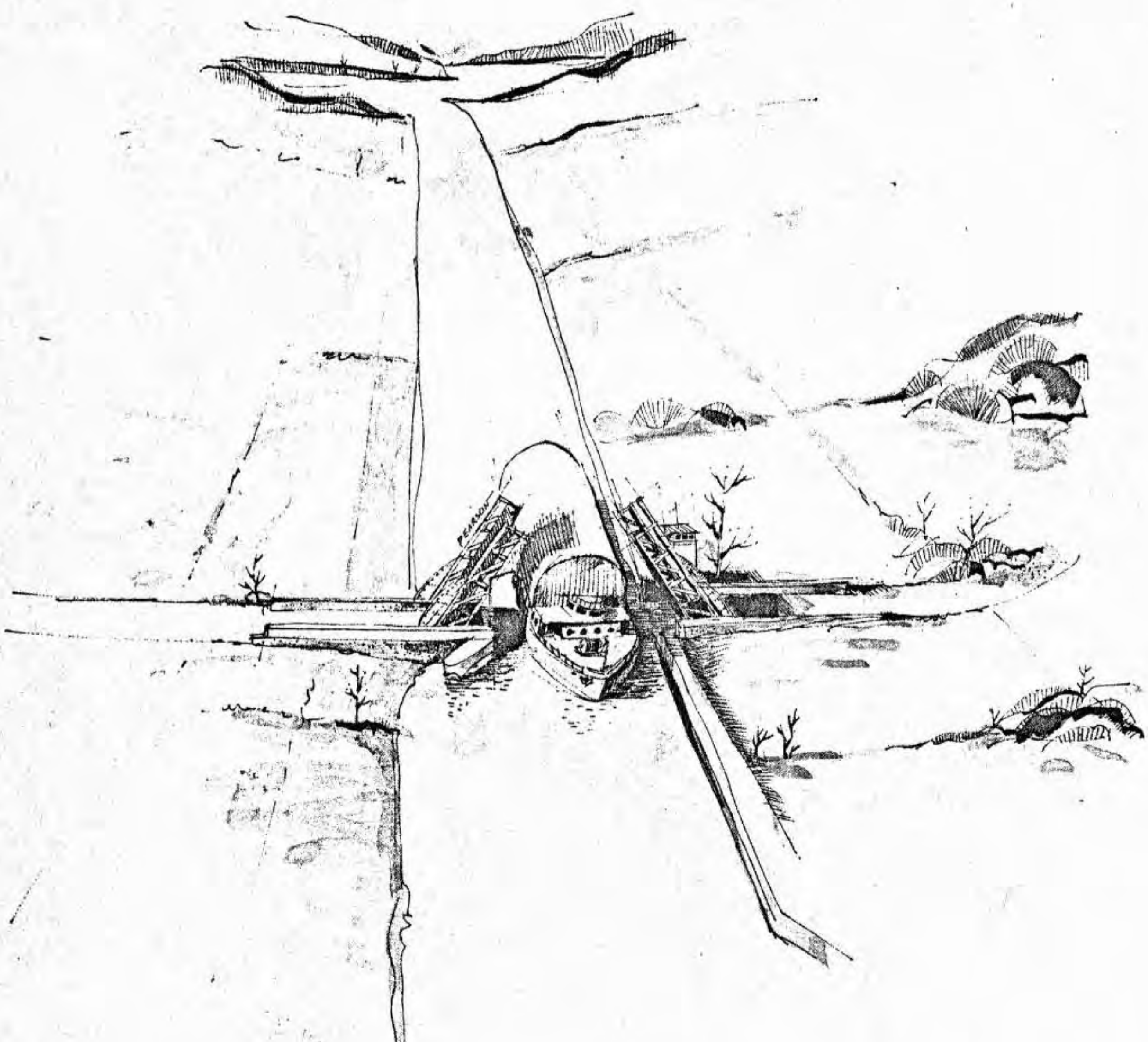
Static firing flash reports and final static firing reports delivered during FY 1968 are:

S-IC-5 - T5-6727-5 static firing report (flash) MTF Test 5-1, August 31, 1967

T5-654-5 static firing report (final) MTF Test 5-1, October 24, 1967

FACILITIES PLANNING & ACTIVATION

3



SUMMARY

Facilities improvement activities at Michoud during the fiscal year were concerned with improvement of Boeing/Michoud production and fabrication capabilities. As a part of this program, five numerically controlled machines were installed and checked-out. Rearrangement and removal of outmoded machinery is also being accomplished.

As a result of decreased Apollo Saturn Program activity it has been necessary to provide additional space for stage storage at Michoud. During this fiscal year three horizontal storage positions were made available in the Michoud factory. To provide this space it was necessary to relocate certain equipment and work areas. It was also necessary to double deck certain stores areas in the factory building.

Boeing's activation tasks at the Mississippi Test Facility were completed during FY 1967. The formal letter acknowledging completion of the required tasks by The Boeing Company, was received from NASA on April 18, 1968.

Activities at Mississippi Test Facility during the year concentrated on the static firing of the S-IC-5, S-IC-D fuel tank drain tests to determine vortex formations, S-IC-6 static firing preparations, and resolution of problems encountered with test stand ground support equipment. At the end of the fiscal year the S-IC-6 was in the static test stand where it was awaiting captive firing.

tion of certain areas and a reduction of space required for other functions.

The installation of a new 6000 psi GN_2 gas header line in the high pressure test facility was completed during the third quarter of FY 1968. Also, a request for additional paving at the high pressure test facility was submitted and approved as a NASA in-house responsibility. The new paving should be completed early in FY 1969.

SUPPORT AND GENERAL PLANT

ROCKETDYNE FACILITIES MODIFICATIONS

Modifications to the Rocketdyne area of the manufacturing building were accomplished during March 1968. These modifications, which were requested by NASA, consisted of providing an office area and additional clean room capability, upgrading the helium supply, and completing other modifications which provided Rocketdyne with a complete working operation. Also in March 1968, at NASA's request, all thermal insulation blankets were transferred to Rocketdyne for modification prior to shipment to KSC. Rocketdyne was also assigned 23,000 square feet of storage space on the south mezzanine to provide the space necessary to store and modify the insulation blankets.

UTILIZATION FACILITIES FOR EQUIPMENT

A utilization system for equipment was completed in November 1967 and it will be implemented as soon as the switchover to third-generation computers is complete. This is an electronic system that monitors utilization of equipment items, such as machine tools and related production support equipment. Utilization is defined in terms of equipment run time, time under load, downtime and maintenance time, and is measured and recorded in actual hours on a real-time basis. The system is completely automatic from point of origin to actual recording, and can monitor up to 1000 pieces of equipment. All monitored equipment is connected to a central recording console via hardwire, and utilization of each equipment item is recorded on a machine processible format for computer input.

MICHOUD FABRICATION PLANS AND ACTIVITIES

GENERAL PLANT

The Facilities organization has implemented a centralized store concept that incorporates all general-purpose type test and production equipment. This plan was implemented in view of the decreasing availability of funds for additional equipment and the increasing need for better utilization of our existing equipment. It is estimated that there will be over 10,000 general-purpose type items that will be controlled and issued through the centralized store.

During the past year, a rebuild shop, which allows Boeing/Michoud to rehabilitate machines that would otherwise require outside support, was established.

OFFICE

Significant progress toward reducing costs on the Saturn program was made during the fourth quarter of FY 1968 by consolidating office space. Plans are to deactivate, in early FY 1969, the entire southeast wing, first floor, of the Office and Engineering Building (No. 350). This will result in a considerable reduction in operations and maintenance costs over the ensuing years.

TRAFFIC

The Facilities organization, in conjunction with the NASA-Michoud Traffic Safety Board, alleviated a large number of internal safety and traffic problems by installing caution signs at dangerous intersections, adding additional speed limit signs and roadway markings, rerouting traffic and rearranging parking spaces in the parking lots.

STAGE STORAGE

Early in FY 1968, it was recognized that there was not sufficient storage area for S-IC stages at Michoud. This inadequacy became a reality when revisions occurred in the transfer and transportation schedules of stages from Michoud to KSC. At this time, Facilities planning prepared several proposals and a recommendation to solve this problem. The stage storage plan was presented, accepted, and approved by NASA. To implement the plan, it was necessary to relocate the specimen preparation area and major painting facility, and to double-deck certain stores areas within the plant.

Supplemental Agreement MICH-596 was received in August approving the storage plan. As a result, 14,000 square feet of double-decking was constructed for storage space (8000 square feet in the factory building and 6000 square feet in the vehicle component supply building). Positions 1 and 3 were completed on schedule and supported the revised delivery schedule. Position 2 became available in April 1968. All effort connected with this project was completed in June 1968, when the floor and ramp repairs were completed.

AUGMENTATION, MODERNIZATION, REHABILITATION AND REBUILD PROGRAM

Approved FY 1967 funds (Contract NAS8-5606(F)) for modification, replacement, and rehabilitation amounted to $1,895,195. These funds have either been committed or are in the process of being committed. During FY 1968 $930,000 worth of funds were approved for Contract NAS8-5606(F).

MISSISSIPPI TEST FACILITY

Past annual progress reports have concentrated on the facilities activation tasks at MTF. During FY 1967, The Boeing Company's facilities activation tasks at MTF were completed. The letter certifying completion of activation at MTF was submitted to the NASA/MTF Contracts representative for concurrence on January 24, 1968. The letter of completion, recognizing concurrence on the part of The Boeing Company, was received by Boeing on April 18, 1968.

S-IC-5 STATIC FIRING ACTIVITY

The S-IC-5 was installed in the S-IC test stand at MTF on June 29, 1967 (Figure 3-2). Stage electrical connections were completed on July 12, and on July 13, 1967, power was applied. Propellant load tests were completed by August 9, 1967, and the stage was successfully static fired for 125.096 seconds at 6:14 p.m., August 25, 1967 (Figure 3-3). The S-IC-5 stage was removed from the static test stand on September 11, 1967 (Figure 3-4), and returned to Michoud at approximately noon the following day.

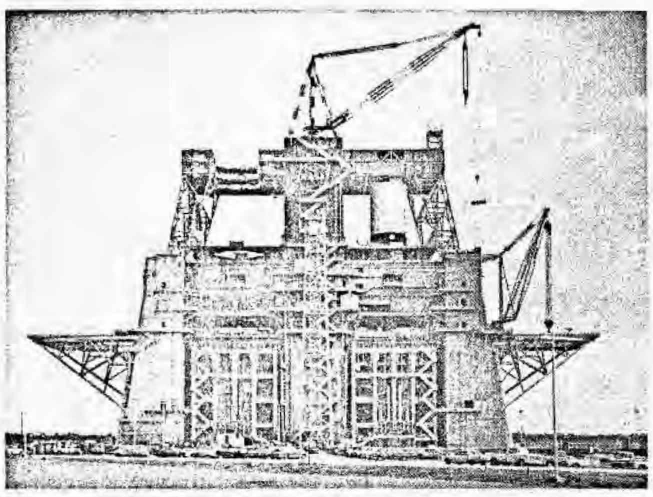


Figure 3-2 S-IC-5 in Test Stand

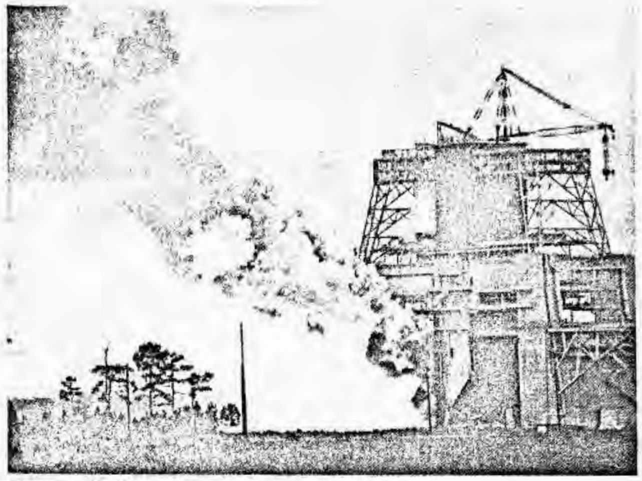


Figure 3-3 S-IC-5 Static Firing

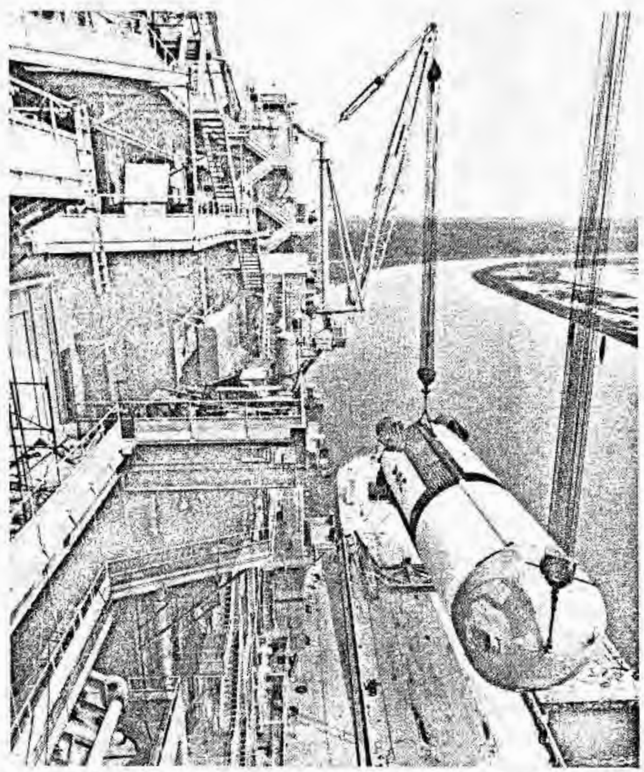


Figure 3-4 S-IC-5 Being Removed From Test Stand

PROBLEMS ENCOUNTERED AND RESOLVED DURING S' S-IC-5 STATIC FIRING ACTIVITY

Thrust Vector Control (TVC) system checkout began July 21, 1967. During checkout, two Hydraulic Research servoactuators were found to be defective. They were returned to the vendor for failure analysis and replaced with serviceable items. TVC system checkout was completed August 4, 1967.

RP-1 tanking commenced July 25, 1967. After tanking had reached 70 percent fill level a shutdown was called due to the collapse of a fuel emergency drain duct (Figure 3-5). An MTF investigating committee was immediately formed to determine the cause of this incident. Special test requirements were outlined to determine the recirculation flow and pressure characteristics of the facility fueling system. These tests were conducted on July 26, 1967, and sufficient negative pressures were encountered within the system to have caused the duct to collapse (a description of the causes of this collapse are on page 45). All stage propellant tests were suspended pending a review and evaluation by the Branch investigation team which was held July 27, 1967. The facility fuel emergency drain duct system was subsequently modified and returned to operational configuration. Final Branch investigation team recommendations for revising LOX loading procedures were complied with prior to propellant load tests, which were completed on August 9, 1967.

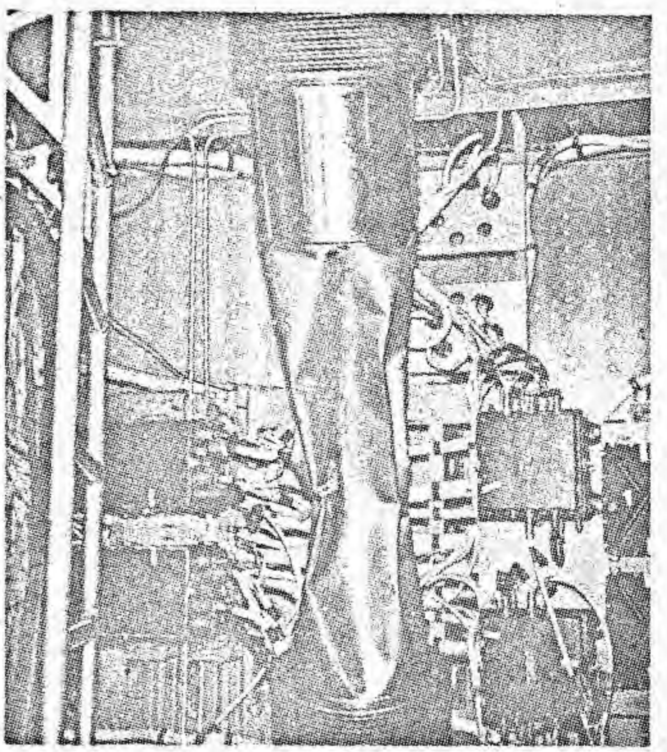


Figure 3-5 Collapsed S-IC-5 Fuel Emergency Drain Duct

During the installation of a heavy manual engine actuator on July 31, 1967, the No. 1 fuel high pressure duct on engine 104 was gouged. After the gouge was polished, in accordance with a Rocketdyne disposition, the No. 1 fuel high pressure duct was too thin to support high pressures, therefore, on August 5, 1967, it was removed and replaced.

During preparation for the S-IC-5 static firing engine servoactuators were changed out 14 times because of leakage, extreme limit cycling, out of specification in the lock-off-null position, and piston rod seal leaks out of tolerance.

During static firing of the S-IC-5, a 2-inch piece of the turbine inlet temperature measuring thermocouple cracked and broke off. Rocketdyne found the piece in one of the turbine manifold nozzles of engine position 102. The piece was removed and the engine returned to operational configuration, a pressure leak check retest was satisfactorily performed on September 8, 1967.

POST-STATIC FIRING ACTIVITY

On August 31, 1967, a stand-up presentation was given by Boeing to summarize the static firing five-day "Quick Look Report." This presentation revealed that 94 percent of the System "A" measurements recorded during static firing of the S-IC-5 were good.

All Certificates of Accomplishment for completion of the S-IC-5 acceptance test procedures were released by September 26, 1967.

S-IC-6 STATIC FIRING PREPARATION

The S-IC-6 stage was shipped from Michoud and arrived at MTF on March 1, 1968. The stage was then placed in the static test stand on March 4, 1968.

A requirement by NASA to rerun six MSE automatic checkout procedures, prior to stage power-on, delayed power-on from March 25, 1968 to April 4, 1968. Three of the six MSE automatic checkout procedures that NASA required to be rerun contained errors and were returned to Michoud for correction. Initial power-on was successfully accomplished on April 4, 1968, and heat shield installation was successfully completed on April 5.

On April 23, 1968, S-IC-6 static firing activity was suspended with the exception of authorized modifications. This was done so that several modifications resulting from AS-502 flight analysis could be incorporated and tested on the S-IC-6 prior to the decision to include them on the S-IC-3; the principal changes to be tested are POGO suppression systems (see page 37). A review of changes affecting the S-IC-6 was conducted with the purpose of "rolling back" all changes practicable for accomplishment prior to a later static firing schedule.

Incorporation of the required POGO suppression system on the S-IC-6 began on June 14, 1968. Stage power-on was accomplished on June 26, and static firing of the S-IC-6 is scheduled for August 6, 1968.

S-IC-D FUEL TANK DRAIN TESTS (ANTI-VORTEX)

A vortexing condition was observed during 1/8th segment fuel tank drain tests at Michoud. A vortex formation in the fuel tank during flight could cause gas ingestion at the engine fuel pump inlets, and could result in engine explosion. Because of a need for further testing, the S-IC-D was installed in the MTF static test stand (Figure 3-6) and modified so that water drain tests could be conducted to determine if a vortexing condition existed in the stage fuel tank. Modifications included removal of the S-IC-D engine simulators, and

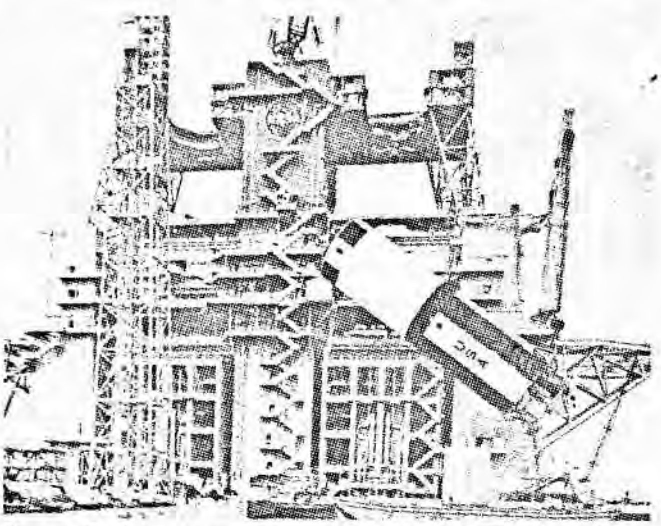


Figure 3-6 Installation of S-IC-D in Test Stand

installation of necessary monitoring equipment including ten plexiglass ducts which were installed on the fuel ducts to allow high-speed photography of bubble ingestion patterns (see Figure 3-7).

Testing began on December 18, 1967 and was completed on January 17, 1968. During that period of time, a total of 20 tests were conducted on four different anti-vortex baffles. The basic test consisted of filling the fuel tank with water to the 40 percent level and then allowing the tank to drain. Drainage was recorded by cameras located inside the tank and other areas to record bubble formation and ingestion.

Test data reduction was completed and presented to MSFC on February 1, 1968. As a result of this meet-

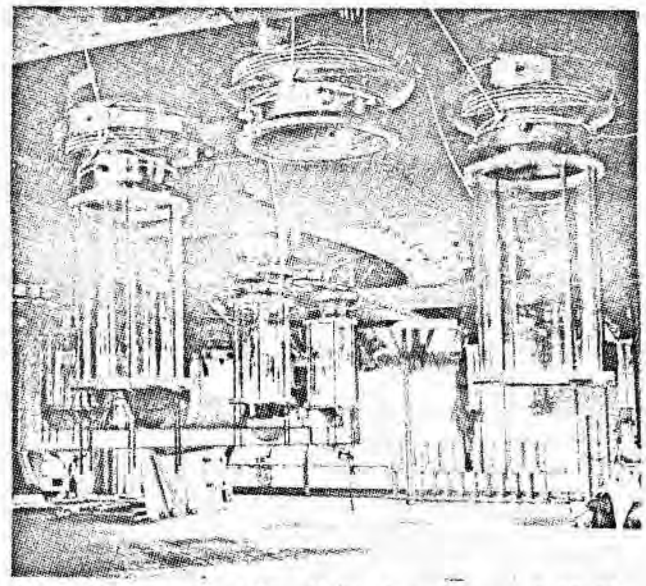


Figure 3-7 Plexiglass Ducts Installed on S-IC-D

ing, it was decided to terminate drain tests, and replace S-IC fuel tank anti-vortex assemblies with assemblies of the same design as those used on S-IC-1 and -2.

PROBLEMS ENCOUNTERED AND RESOLVED WITH GSE

S-IC PNEUMATIC CONSOLE

Work continued throughout FY 1968 to revise the pneumatic console vent and relief circuitry. The original vent and relief circuitry was not designed for a "wide open" regulator failure. If this type of failure was to occur, it would cause an over-pressure condition to exist in the downstream piping and could abort a launch. For various reasons, but principally because of the unavailability of parts, the work of modifying the console was sporadic, workarounds were implemented so console modifications would not affect S-IC-6 power-on.

GROUND EQUIPMENT TEST SET

Because the manual Ground Equipment Test Set (GETS) was designed as a continuity tester with no automatic stage simulation capability, stage sequence tests could not be verified without an S-IC stage. To eliminate the use of an S-IC stage as a test fixture for verifying ground support equipment operation and for developing dry run automatic test programs, the manual GETS system was modified to a super or automatic GETS configuration. This modification was begun on October 10, 1967, and completed November 17, 1967. Functional checkout was completed November 27, 1967.

GSE/MSE

Early in January 1968, General Electric Quality and Reliability Assurance Engineering reported that combining Swagelok and Gyrolok tube fittings could cause "a potential hazard to safety, and a detriment to operation." General Electric had been issuing the tube fittings on the assumption that the two varieties were interchangeable in all combinations. A Boeing committee was appointed to investigate the possibility of any anomalies in the Ground Support Equipment/Manufacturers' Support Equipment (GSE/MSE) installations. An investigation was conducted as a result of their findings and it was determined that no intermixing of Swagelok/Gyrolok tube fitting components existed on the S-IC static test stand, as stated in the committee's report of March 1968.

Work was started in late February of 1968 to provide a capability for remote pressurization and venting of the GOX ducting systems. The test fixture, used to manually vent the GOX ducting system during confidence and leak testing, presented a safety hazard during confidence testing and therefore did not meet personnel safety requirements.

The test fixture was sent to Michoud for rework on February 26, 1968, and a workaround version, borrowed from Michoud, was modified for use at MTF during the time the reworked test fixture was at Michoud.

Modification of the hydraulic terminal equipment to eliminate leakage and/or functional failure of the pneumatically operated ball valves and associated pneumatic and electrical controls, which would cause a delay in static firing, was incorporated. The pipe assembly, necessary for the rework activity, was built at Michoud and delivered to MTF on April 25, 1968. The change was functionally complete on May 13, 1968.

Work to add remote venting capability to gaseous nitrogen (GN_2) control pressure systems was started on March 18, 1968. This was done to eliminate a potential personnel safety hazard by providing remote venting of trapped high pressure GN_2, and to retain sufficient GN_2 pressure to allow prevalve closure during flight to ensure mission completion. The change was originally committed to be installed at Michoud prior to stage shipment to MTF but, because of the late delivery of hardware, the change was made at MTF.

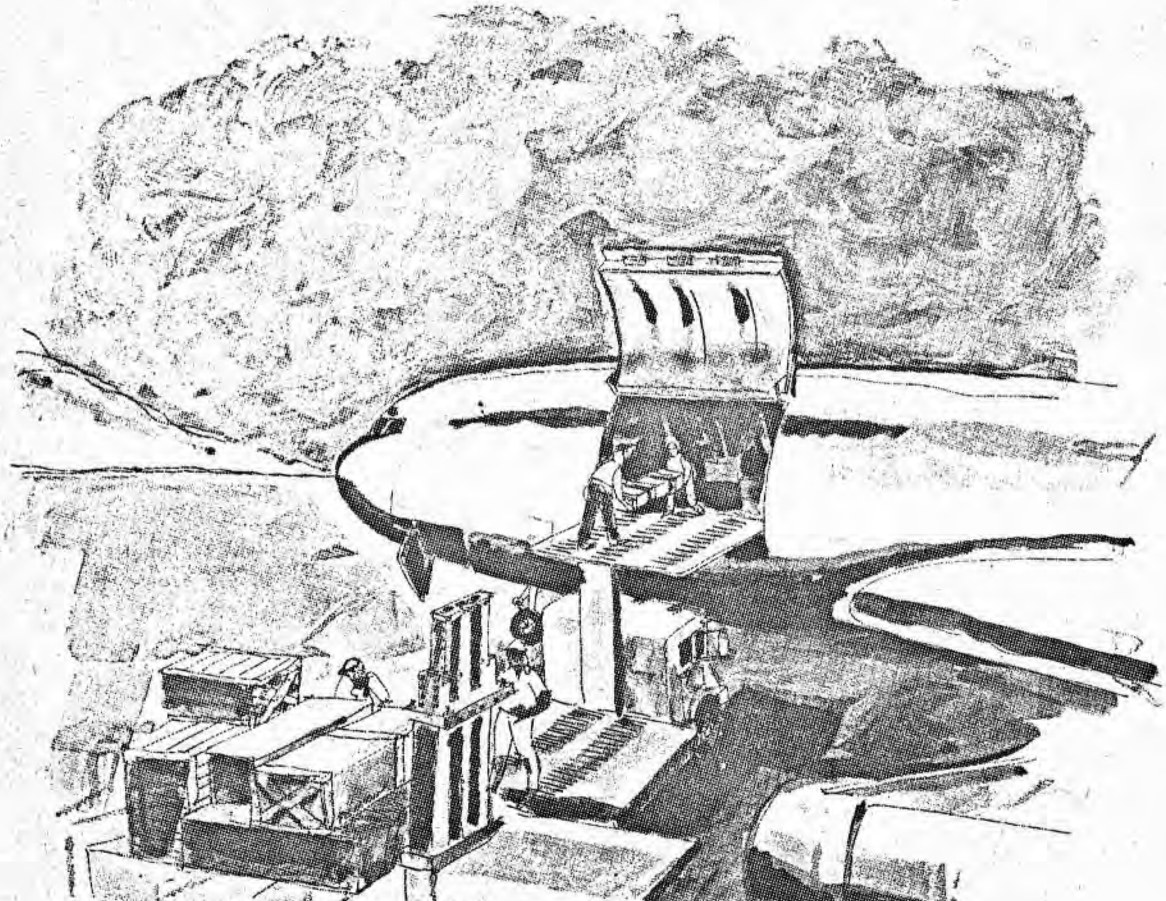
The change to add the above mentioned remote venting to the GN_2 control pressure system made it necessary to remove the stage mounted prevalve accumulator bottles from stages S-IC-6 and on. Certain tests, performed to verify operation without the accumulators, were satisfactorily completed and the change was begun at MTF on March 18, 1968. The tubing required to add remote venting and to remove the accumulator bottles was sent to Michoud for fabrication, testing, and cleaning. Installation and functional checkout was completed on March 26, 1968.

MTF DOCUMENTATION

Boeing/MTF document status for FY 1968 is indicated in Appendix G.

LOGISTICS

4



SUMMARY

During FY 1968 Boeing/Michoud Logistics Engineering's participation in the S-IC Logistics Support Program consisted of:

a) Spares support for S-IC-1 through S-IC-8 at Michoud, MTF, and KSC;

b) Spares support for test and checkout equipment at Michoud and MTF;

c) Spares support for Boeing-furnished S-IC stage-peculiar GSE delivered to MTF and KSC; and

d) Field support engineers at MTF and KSC.

DOCUMENTATION SUPPORT

"S-IC LOGISTICS LAUNCH SUPPORT PLAN," D5-13705

This document describes the actions necessary to assure complete and timely Schedule 1 logistics support for the S-IC launch, and has been updated to incorporate changes resulting from the S-IC-1 launch. However, there have been no significant changes in the manner or scope of logistics support.

SPARE PARTS STATUS SUMMARY

The Stock Status and Consumption Report, DRD MF-506B of IN-I-V-S-IC-65-10, has been deleted by contract change and replaced by a Spare Parts Status Summary, DRD LS-078 of IN-I-V-S-IC-67-10, for each stage. Reporting for the summary of each stage is to begin thirty days prior to the on-dock KSC date, and will reflect logistics' support position for that stage.

TECHNICAL SUPPORT DATA

Publication of S-IC stage and GSE technical manuals continued on or ahead of schedule throughout FY 1968. During this period a complete revision on the S-IC-2 Stage Maintenance and Stage Flight Measurement Manuals was published. Also, a total of fifteen GSE technical manuals were revised.

"LOGISTICS INFORMATION REPORTING SYSTEM," D5-13759

The implementation of third-generation computing equipment necessitated reprogramming the logistics reporting system. A study was conducted to devise a system which would utilize the potentials of advanced computing equipment and better satisy logistics' needs. The resulting system has been documented in D5-13759, "Logistics Information Reporting System," and is scheduled to be implemented during October 1968.

CENTRALIZED INVENTORY CONTROL SYSTEM

Implementation of a centralized inventory control system was postponed because of a delay in the availability of video displays Cathode Ray Tube (CRT) units. When available, these units will allow direct communication with the file in a third-generation on-line computer, and will function as an integral part of the logistics program.

SPARES SUPPORT

Three "spares" hardware stores were supported during FY 1968. The Michoud store was used as a central store for test site provisioning and as a site support store for post-manufacturing checkout and post-static test checkout operations at Michoud.

Stock at the MTF store was built up and maintained in support of S-IC-5 and -6 static tests. A limited number of parts from the MTF stores were diverted to KSC for backup support of launch critical applications, however, a full inventory level at MTF was maintained. The S-IC-1 and -2 launches were successfully supported with no delays caused by spares shortages. At the end of the fiscal year, stock levels were satisfactory at all sites.

The task of refining and operating an effective Boeing/vendor repair program for failed repairable components is being reviewed. This review has important implications for future spares support due to extensions in the program performance period.

PERSONNEL SUPPORT

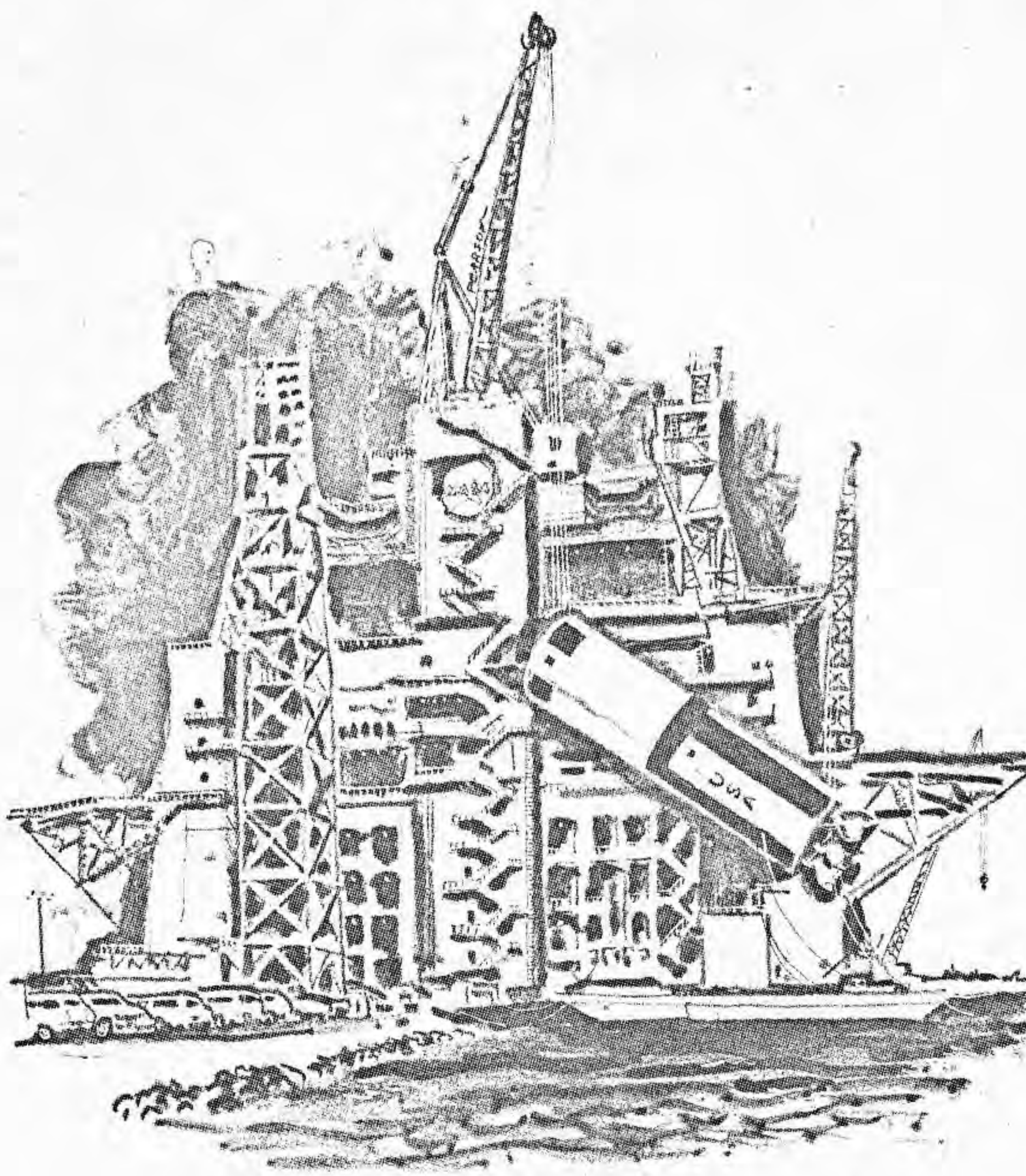
To assist BATC in the spares liaison effort to support the S-IC-2 test and launch, Logistics Engineering placed two additional spares maintenance representatives at KSC prior to the beginning of the Countdown Demonstration Test. The loan of these two additional liaison personnel provided round-the-clock liaison between Michoud and KSC, resulting in rapid resolution of any spares problems that might have impacted test and launch operations. The personnel on loan returned to Michoud immediately after the launch.

SPARES FOR GOVERNMENT FURNISHED EQUIPMENT

A logistics problem was encountered with the GFE provided to MTF by MSFC and operated by Boeing. This problem is associated with lack of design definition and resulted in our inability to obtain formal design and drawing corrective action on discrepancies noted during spares provisioning and procurement activities. However, in spite of such problems, the spares support position for GFE has continually improved during this reporting period.

STAGE SYSTEM STUDIES

5



No work was done under this part of the contract in FY 1968

LAUNCH OPERATIONS

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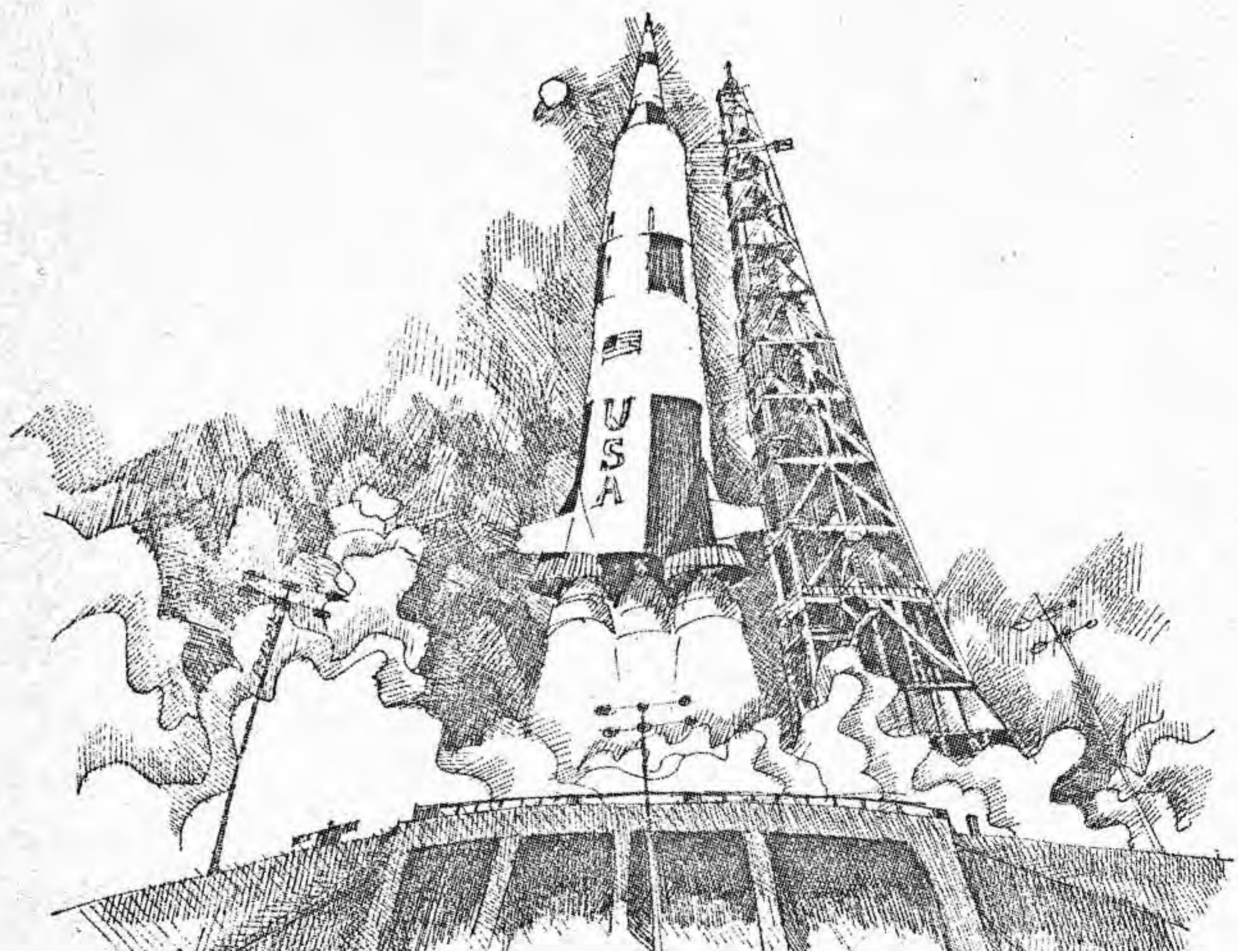


LAUNCH OPERATIONS

There has been an on residence Test Conductor at BATC from S-IC Systems Test, Test Engineering and Operations - Michoud to support AS-503 processing.

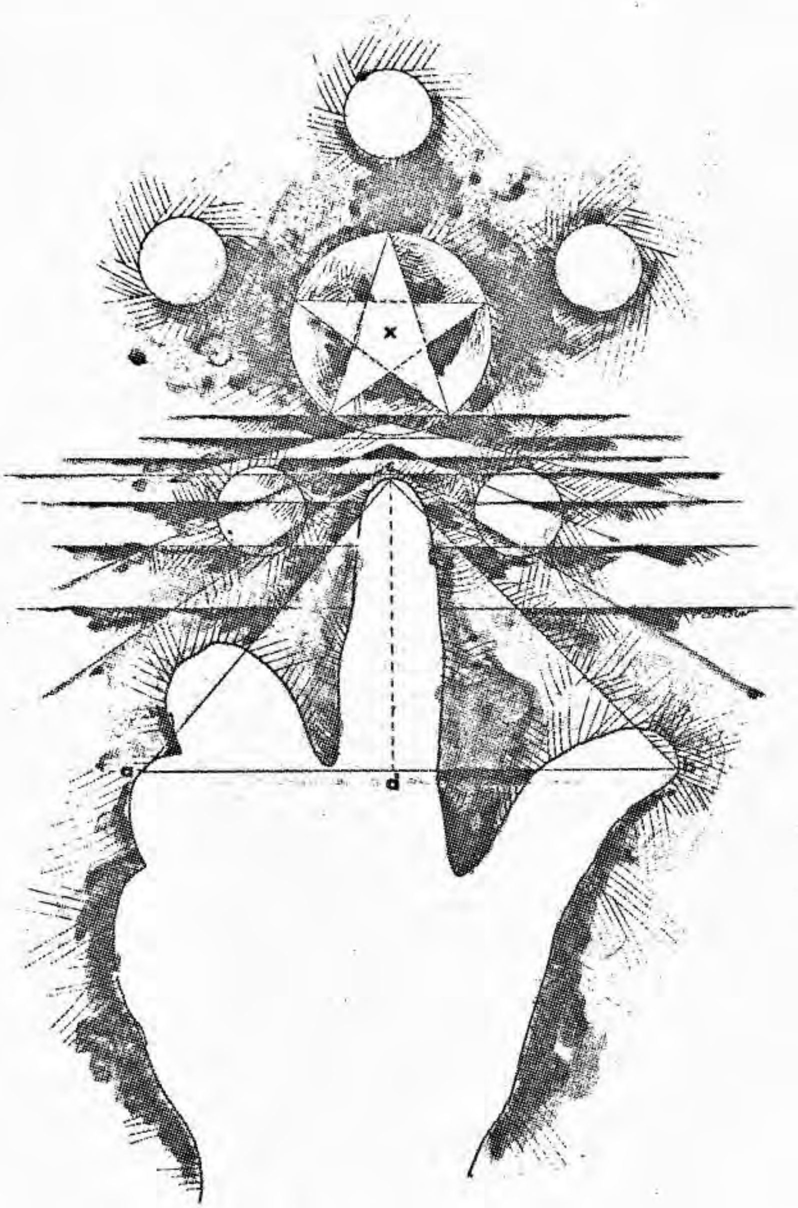
S-IC-3 QUALITY VERIFICATION

S-IC Systems Test participated with Michoud Engineering Configuration Management and Q&RA, in an in-depth review and audit of all change incorporation, rework and retest activity involving the S-IC-3 from the end of Post-Manufacturing Checkout (Simulated Static Firing, 8-24-66) through May 1968. This review was directed by NASA as a result of the AS-502 flight failures. The initial Branch report was submitted to the customer on June 5, 1968.

Data submitted consisted of two packages which covered all Michoud and KSC activities. A review of the Michoud activities data was conducted by the NASA modification and evaluation team between June 5 and June 14, 1968. No system deficiencies were noted at the completion of this review.

ADVANCED STUDIES

7



No work was done under this part of the contract in FY 1968

APPENDIXES

APPENDIX A
CONTRACT MODIFICATIONS

The number of contract modifications received during the period July 1, 1967 through June 30, 1968, is as follows:

Contract NAS8-5606(F)	-	6
Contract NAS8-5608	-	251
Contract NAS8-19544	-	3

APPENDIX B
PROPOSALS SUBMITTED

The number of firm cost proposals submitted to NASA during the period July 1, 1967 through June 30, 1968, is as follows:

Contract NAS8-5608	-	121

These proposals had a total approximate value of $49,725,161.

APPENDIX C
NEGOTIATIONS COMPLETED

The number of negotiations completed with NASA during the period July 1, 1967 through June 30, 1968, is as follows:

Contract NAS8-5608	-	93*
Contract NAS8-19544	-	1

*Totaling approximately $8,155,063

APPENDIX D
DELIVERABLE DATA SUBMITTED

The number of items of deliverable data submitted to NASA during the period July 1, 1967 through June 30, 1968, is as follows:

Contract NAS8-5606(F)	-	18
Contract NAS8-5608	-	1,607*
Contract NAS8-19544	-	2

*The average line item of deliverable data under this contract requires approximately eighty (80) pages.

APPENDIX E

ENGINEERING CHANGE DOCUMENTATION COMPLETED DURING FISCAL YEAR 1968

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0247	Provide filter networks to reduce noise susceptibility and realign LOX and fuel loading electronics assemblies	1-15	
0248	Replace orifice in fuel prepressurization module of the S-IC pneumatic console		MTF 1 MILA 1, 2, 3 MAB
0249	Redesign aft umbilical #1, #2, and #3 ball valve actuator arm		MILA 1, 2, 3
0250	Remove ground umbilical fluid couplings from spare locations in S-IC umbilical equipment	3-15	MILA 1, 2, 3 MSE 1, 2
0261	Replace helium shutoff valve with a check valve	1-2	MAB
0264	Replace roller stops on LOX interconnect support bracket installation	1-15	
0265	Replace roller cams on LOX interconnect support brackets	1-3	
0266	Provide capability to vent downstream of helium bottle fill isolation valve		MTO 1 MAB MILA 1, 2, 3
0267	Rework circuitry of the DC-DC converter and DC power isolator	1-15	
0269	Provide separate vent lines for the preservation module of the forward umbilical service unit		MILA 1, 2, 3
0270	S-IC engine alignment check		MTF 1
0273	Provide identification of S-IC stages by numbers	3-15	
0275	Provide manual ground control of stage prevalves at KSC	1	MILA 1, 2, 3
0276	Provide power-off turbopump seal purge capability	1-15	MILA 1, 2, 3
0279	Prevent corrosion of spherical rod-end bearing used throughout the S-IC stage structure	2-15	
0280	Provide electrical bonding of retrorocket and CDF manifold	1-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0285	Incorporate improved lockwire installation procedure on fluid power system duct insulation installation	3-15	
0286	Revise visual instrumentation camera port squib cable assembly	2, 3	
0288	Add remote venting capability of GN_2 control pressurization system	2-15	MTF 2 MSE 1, 2 MAB
0289	Remove stage mounted prevalve accumulator bottles from the S-IC vehicle	6-15	MAB
0290	Modify the fuel tank prepressurization module of the S-IC pneumatic console		MTO 1 MILA 1, 2, 3 MAB
0291	Revise engine cocoon thermal conditioning controls and thermocouple cable acceptance test requirements		MILA 1, 2, 3 MAB
0295	Revise S-IC Level I electromagnetic compatibility test requirements	7-15	
0298	Add inlet filter to the forward umbilical service unit		MILA 1, 2, 3
0299	Provide sealing of stage structure to prevent equipment damage from rain water	1-15	
0300	Provide redundant electrical power circuit for fuel pressurization system	3-15	
0302	Replace 50M04050-1 Hydraulic Research servo-actuator with 60B84500-1 MOOG servoactuator	1	
0303	Modify the S-IC pneumatic console LOX/fuel prepressurization modules		MILA 1, 2, 3 MTO 1 MAB
0305	Rework 60B84500-3 Hydraulic Research servoactuator	3-15	
0306	Rework prefiltration valve subassembly on MOOG servoactuator 60B84500-1	3-15	
0309	Relocate the positive pressure line on the LOX and fuel tank upper bulkheads	4-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0312	Provide separate mounting of three pilot relief valve subassemblies in the S-IC pneumatic console		MTF 1 MILA 1, 2, 3 MAB
0313	Revise electrical surge suppression circuits in the S-IC pneumatic console		MTF 2 MILA 1, 2, 3 MAB
0315	Delete non-flight hardware from flight documentation	2-15	
0316	Rework the Hydraulic Research servoactuator 50M04050-1 removed from S-IC-1 and use them for S-IC-2	2	
0318	Add LOX pressure sensing line to the inter-tank umbilical reconnect assembly		MILA 1, 2, 3
0320	Revise fairing turn buckle attachment fitting material to 7075-T73	1-15	
0321	Provide Parker LOX vent and relief valve as standby for Whittaker LOX vent and relief valve	1	
0322	Provide explosion proof enclosure for pre-valve ground accumulator pressure spheres		MTF 2 MILA 1, 2, 3
0323	Revise S-IC propellant dispersion system installation	2-15	
0324	Revise test requirements and procedures for ordnance safe and arm device	2-15	
0328	Rework the intertank umbilical locking mechanism		MILA 1, 2, 3
0329	Reroute cable installation on fins B and D	2-3	
0330	Substitute amplifier used for ten mandatory prelaunch red line temperature measurements	3-15	
0332	Revise the S-IC stage thrust structure hazardous gas detection system to provide sampling orifice in each quadrant	3-15	
0335	Remove, retest and re-identify all 65B23280 check valves		MSE 1, 2 MTF 1 MILA 1, 2, 3
0344	Modify the fairing heat shield access panels	3-15	
0345	Add weather protection covers to base air scoops	2-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0347	Eliminate 17-7 PH mechanical feed back springs in Hydraulic Research S-IC servo-actuators	3-15	
0349	Trim engine fairing skin to prevent injury to personnel	3-15	
0351	Modify servoactuator jack pin assembly		MSE 1, 2 MTF 1 MILA
0354	Revise material of stage anti-friction plates	3-15	
0355	Provide additional vents for the servo-actuator and Boeing supplied engine thermal insulation	2-15	
0356	Modify servoactuator boot fitting installation to replace fasteners with through bolts	3-15	
0357	Change S-IC documentation to comply with KSC pull test requirements	2, 3	
0358	Provide positive moisture sealing of electrical cavities for the 60B49002 helium pressurization and emergency dump valves	2-15	
0359	Incorporate improved position switches in the LOX tank vent and relief valve (60B51002)	2-15	
0360	Installation of the ordnance bracket assembly on the LOX and fuel tanks	2-4	
0363	Protect electrical cables at entry (forward and aft) to stage from electrical tunnel	2-15	
0367	Revise S-IC propellant dispersion system installation kit		KSC Genl
0369	Provide uninterrupted power (+28 VDC) to LOX and fuel loading electronics	3-15	
0371	Modify S-IC intertank umbilical lock mechanism		MILA 1, 2, 3
0372	Modify the S-IC pneumatic console helium primary regulation circuit		MAB MTF 1 MILA 1, 2, 3
0374	Revise the main seal in the LOX fill and drain valve	3-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0377	Modify the S-IC storage racks to provide protection during launch		MILA 1
0379	Replace vent seals on all Airesearch prevalves and emergency drain valves	5-15	
0382	Eliminate He flow overlap of the stage and ground fuel tank pressurization system	2-15	MSE 1, 2
0389	Modify filter manifold delta pressure	3-15	
0396	Block debris valves in S-IC intertank reconnect assembly LOX fill and drain lines in the open position		MILA 1
0401	Provide locking and position indicating mechanism for S-IC pneumatic console and forward umbilical service unit		MTF 1 MILA 1, 2, 3 MAB
0406	Modify TV objective lens housing assembly	2, 3	
0411	Provide drain for servoactuator rod seal leakage	2-15	
0414	Replace bolts in fairing heat shield access panel	3-15	
0415	Replace 50M04049 MOOG servoactuator with 60B84500 MOOG servoactuator	2	
0419	Provide new latch on the S-IC intertank umbilical reconnect assembly		MILA 1, 2, 3
0848 R1	Replace pressure gage in forward umbilical service unit		LUT #1, #2, #3
0866 R1	Modify heater blanket assemblies	1-3	
0867 R1	Modify base heat shield installation	1-15	
0868 R1	Modify connector hex nut	3-5	
0870 R1	Modify base heat shield support angle installation	1-4	
0871 R1	Correct bolt lengths on lower fairings	3-15	
0873 R1	Modify support installation to allow installation of the recoverable camera	2, 3	
0874 R1	Correct bolt length on thrust structure base air scoop installation	1-15	
0875 R1	Provide pilot relay for heater power contactor in S-IC pneumatic console		MILA 1, 2, 3 MTF 1

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0876 R1	Modify ground cables in TV camera system	2, 3	
0877 R1	Modify retrorocket initiation system	1-15	
0879 R1	Modify tube assembly in the pneumatic console		MILA 1
0880 R1	Eliminate an out-of-tolerance condition in the LOX leakmeter measurement F45-118	1-5	
0883 R1	Correct bolt length callout on servoactuator boot installation	1-15	
0884 R1	Modify length of cable assembly 115W305	1-5	
0885 R1	LOX fill and drain valves (B-239, B240) control valves reversed cables		MILA 1, 2, 3 MAB MTF 1
0887 R1	Calorimeter purge line clamp	2-5	
0889 R1	Modify S-IC intertank umbilical to delay closure of debris valve		MILA
0891 R1	Heat shield panel installation	2, 3	
0892 R1	Electrical installation forward skirt	2, 3	
0893 R1	Eliminate leakage in LOX pressure sensing line		MILA 1, 2, 3
0896 R1	Housing assembly aft 1 and 2		MILA 1, 2, 3
0897 R1	Rebonding of anti-friction plates	2	
0903 R1	Engine fairing blanket assembly	2-15	
0904 R1	Cable and instrumentation installation units 101 and 102	2-4	
0906 R1	Measurement installation fin B	2, 3	
0907 R1	Propellant dispersion system installation and retrorocket initiation system	2-15	
0908 R1	Change bolt callout	2-15	
0913 R1	Base heat shield bracket misalignment	3-15	
1214 G	Increase accuracy of GOX flow control valve pilot pressure measurement		MSE 1, 2
1219 G	Revision to stage handling requipment (MAB VAB)		MAB

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
1221 G	Utilize RCA 110A as primary engine test programmer		MTF
1225 S	Replace roller cams on LOX interconnect support bracket installation	4-15	
1226 G	Modify MTF rotational brace		MTF 1
1232 G	Modify pin puller assemblies and adjustment linkage assembly at MTF		MTF 1
1235 S	Provide self-aligning capability for engine fairing turnbuckles	5-15	
1236 S	Redesign rate gyro heater blanket assembly	10-15	
1237 S	Relocate engine actuator electrical filter assembly	5-15	
1239 S	Revise 60B19612-1 static firing anti-friction plates to facilitate removal	6-15	
1240 G	Provide capability for remote pressurization and venting of the GOX ducting system		MTO 1
1243 G	Modify aluminum forward handling ring test requirements	7-15	
1246 G	Provide temporary environmental protection for servoactuators		MTF 1

APPENDIX F

ENGINEERING CHANGE DOCUMENTATION INITIATED DURING FISCAL YEAR 1968

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0216	Reduce the fuel and LOX tank standby pressure output in the forward umbilical service unit		MILA 1, 2, 3
0231 * Cancelled	Provide S-IC engine hydraulic system pressurization for stage shipment and storage		MILA 1, 2, 3 MTO 1
0242	Modify S-IC pneumatic console to provide pressure calibration source in mobile launcher room		MILA 1, 2, 3 MAB
0247	Provide filter networks to reduce noise susceptibility and realign LOX and fuel loading electronics assemblies	1-15	
0248	Replace orifice in fuel prepressurization module of the S-IC pneumatic console		MTF 1 MILA 1, 2, 3 MAB
0249	Redesign aft umbilical #1, #2, and #3 ball valve actuator arm		MILA 1, 2, 3
0250	Remove ground umbilical fluid couplings from spare locations in S-IC umbilical equipment	3-15	MILA 1, 2, 3 MSE 1, 2
0251	Modify the length of the telemetry antenna feed cables	3-15	
0260 * Cancelled	Replace angular rate gyros for measurements R4-120, R5-120 and R6-120	2-15	
0261	Replace helium shutoff valve with a check valve	1-2	MAB
0263 * Cancelled	Provide venting for stage access equipment storage racks		MILA 1, 2, 3
0264	Replace roller stops on LOX interconnect support bracket installtion	1-15	
0265	Replace roller cams on LOX support brackets	1-3	
0266	Provide capability to vent downstream of helium bottle fill isolation valve		MTO 1 MAB MILA 1, 2, 3
0267	Rework circuitry of the DC-DC converter and DC power isolator	1-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0269	Provide separate vent lines for the preservation module of the forward umbilical service unit		MILA 1, 2, 3
0270	S-IC engine alignment check		MTF 1
0272	Provide S-IC forward skirt access equipment for access to S-II engines	2-15	
0273	Provide identification of S-IC stages by numbers	3-15	
0274 * Cancelled	Remove umbilical fluid coupling from spare location on S-IC umbilical equipment	2-15	MSE 1, 2 MTF MILA 1, 2, 3
0275	Provide manual ground control of stage prevalves at KSC	1	MILA 1, 2, 3
0276	Provide power-off turbopump seal purge capability	1-15	
0279	Prevent corrosion of spherical rod-end bearing used throughout the S-IC stage structure	2-15	
0280	Provide electrical bonding of retrorocket and CDF manifold	1-15	
0285	Incorporate improved lockwire installation procedures on fluid power system duct insulation installation	3-15	
0286	Revise visual instrumentation camera port squib cable assembly	2, 3	
0287	Modify Marotta solenoid valves (65B23278)		MTF 1 MILA 1, 2, 3 MSE 1, 2 MAB
0288	Add remote venting capability of GN_2 control pressurization system	2-15	MTF 2 MSE 1, 2 MAB
0289	Remove stage mounted prevalve accumulator bottles from the S-IC vehicle	6-15	MAB
0290	Modify the fuel tank prepressurization module of the S-IC pneumatic console		MTO 1 MILA 1, 2, 3 MAB
0291	Revise engine cocoon thermal conditioning controls and thermocouple cable acceptance test requirements		MILA 1, 2, 3, MAB

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0292	Provide backup engine pump seal purge systems		MTF 1 MILA 1, 2, 3 MAB
0293	LOX engine cutoff sensor solar cell redesign	2-15	
0294 * Cancelled	Add a mechanical relief valve in the helium bottle gas storage system	3,4	
0295	Revise S-IC Level I electromagnetic compatibility test requirements	7-15	
0296	Add instrumentation provisions to the S-IC pneumatic console forward umbilical service unit and S-IC umbilicals		MILA 1
0297	Provide digital range safety command system antenna shields	2-15	
0298	Add inlet filter to the forward umbilical service unit		MILA 1, 2, 3
0299	Provide sealing of stage structure to prevent equipment damage from rain water	1-15	
0300	Provide redundant electrical power circuit for fuel pressurization system	3-15	
0301 * Cancelled	Incorporation of second source LOX vent and relief valve	6-15	
0302	Replace 50M04050-1 Hydraulic Research servo-actuator with 60B84500-1 MOOG servoactuator	1	
0303	Modify the S-IC pneumatic console LOX/fuel prepressurization modules		MILA 1, 2, 3 MTO 1 MAB
0305	Rework 60B84500-3 Hydraulic Research servo-actuator	3-15	
0306	Rework prefiltration valve subassembly on MOOG servoactuator 60B84500-1	3-15	
0309	Relocate the positive pressure line on the LOX and fuel tank upper bulkheads	4-15	
0310 * Cancelled	Add umbilical interface measurements to vehicle IP&C list	1-15	
0311	Provide redundant circuitry and power in the stage separation system	3-15	MTF 1 MILA 1, 2, 3 MSE 1, 2

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0312	Provide separate mounting of three pilot relief valve subassemblies in S-IC pneumatic console		MTF 1 MILA 1, 2, 3 MAB
0313	Revise electrical surge suppression circuits in the S-IC pneumatic console		MTF 2 MILA 1, 2, 3 MAB
0314	Add calibration valve to pressure switch sensing line		MILA 1, 2, 3
0315	Delete non-flight hardware from flight documentation	2-15	
0316	Rework the Hydraulic Research servo-actuator 50M04050-1 removed from S-IC-1 and use them for S-IC-2	2	
0317 * Cancelled	Combustion chamber pressure measurement telemetry channel change	5-15	
0318	Add LOX pressure sensing line to the intertank		MILA 1, 2, 3
0319	Provide redundant 28 VDC monitoring power circuitry in the S-IC pneumatic console		MTF 1 MILA 1, 2, 3 MAB
0320	Revise fairing turn buckle attachment fitting material to 7075-T73	1-15	
0321	Provide Parker LOX vent and relief valve as standby for Whittaker LOX vent and relief valve	1	
0322	Provide explosion proof enclosure for prevalve ground accumulator pressure spheres		MTF 2 MILA 1, 2, 3
0323	Revise S-IC propellant dispersion system installation	2-15	
0324	Revise test requirements and procedures for ordnance safe and arm device	2-15	
0325	Provide a redundant method for initiating center engine cutoff under LOX depletion condition	2-15	MTO 1 MILA 1, 2, 3 MSE 1, 2
0326 * Cancelled	Delete BMS8-38 sta-foam from S-IC electrical distributors	3-15	
0327	Modify the LOX vent and relief valve configuration by removing the actuator gear clutch springs	9-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0328	Rework the intertank umbilical locking mechanism		MILA 1, 2, 3
0329	Reroute cable installation on fins B and D	2-3	
0330	Substitute amplifier used for ten mandatory prelaunch red line temperature measurements	3-15	
0332	Revise the S-IC stage thrust structure hazardous gas detection system to provide sampling orifice in each quadrant	3-15	
0333	Replace vibration transducers 60B72188-3 with 60B72184-1 for 17 measurements in the engine area	2-5	
0335	Remove, retest, and re-identify all 65B23280 check valves		MSE 1, 2 MTF 1 MILA 1, 2, 3
0336	Revise F-1 engine cocoon temperature transducer	3-15	
0337 * Cancelled	Replace resistors on printed circuit of telemetry oscillator assembly	11-15	
0338 * Cancelled	Replace the RN 55C1253F resistor in the 50M65485-1 printed wiring assembly in the subcarrier oscillator assembly	11-15	
0339	Correct cabling installation design deficiencies on S-IC stage	3	
0344	Modify the fairing heat shield access panels	3-15	
0345	Add weather protection covers to base air scoops	2-15	
0346	Redesign the LOX overfill sensor	4-15	
0347	Eliminate 17-7 PH mechanical feedback springs in Hydraulic Research S-IC servoactuator	3-15	
0348	Eliminate single failure mode in outboard engine cutoff measurements for time base T-3	3-15	
0349	Trim engine fairing skin to prevent injury to personnel	3-15	
0350	Provide attaching holes for hold down arms hood closure lanyard	2-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0351	Modify servoactuator jack pin assembly		MSE 1, 2 MTF 1 MILA 1, 2
0352 * Cancelled	Provide special handling equipment at KSC	4-15	
0353	Redesign of remote digital sub-multiplexer power supply	3-15	
0354	Revise material of stage antifriction plates	3-15	
0355	Provide additional vents for the servoactuator and Boeing supplied engine thermal insulation	2-15	
0356	Modify servoactuator boot fitting installation to replace fasteners with through bolts	3-15	
0357	Change S-IC documentation to comply with KSC pull test requirements	2-3	
0358	Provide positive moisture sealing of electrical cavities for the 60B49002 helium pressurization and emergency dump valves	2-15	
0359	Incorporate improved position switches in the LOX tank vent and relief valve (60B51002)	2-15	
0360	Installation of the ordnance bracket assembly on the LOX and fuel tanks	2-4	
0362	Provide redundant electrical circuits to eliminate single failure modes in the engine cutoff system	3-15	MSE 1, 2 MTO 1
0363	Protect electrical cables at entry (forward and aft) to stage from electrical tunnel	2-15	
0365	Revise S-IC pneumatic console documentation		MILA 1, 2, 3 MAB
0367	Revise S-IC propellant dispersion system installation kit		KSC Genl
0368* Cancelled	Delete brackets from LOX and fuel tanks	13-15	
0369	Provide uninterrupted power (+28 VDC) to LOX and fuel loading electronics	3-15	
0370	Redesign of GOX feeder duct (60B51403-1)	3-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0371	Modify S-IC intertank umbilical lock mechanism		MILA 1, 2, 3
0372	Modify the S-IC pneumatic console helium primary regulation circuit		MAB MTF 1 MILA 1, 2, 3
0373 * Cancelled	Requirements for structural load monitoring at KSC	2-3	
0374	Revise the main seal in the LOX fill and drain valve	3-15	
0375	Delete forward skirt umbilical door	4-15	
0376	Reduce minimum pressure requirement for stage helium bottles and delete the helium bottles high pressure checkout switch	4-15	MTO 1 MILA 1, 2, 3 MAB
0377	Modify the S-IC storage racks to provide protection during launch		MILA 1
0378	Provide additional fasteners for S-IC intertank umbilical reconnect assembly control box covers		MILA 1, 2, 3
0379	Replace vent seals on all Airesearch prevalves and emergency drain valves	5-15	
0381 * Cancelled	Provide "power off" turbopump seal purge capability	3-15	
0382	Eliminate He flow overlap of the stage and ground fuel tank pressurization system	2-15	MSE 1, 2
0383	Eliminate water acceptance testing for Airesearch fuel prevalve 20M32011-13	11-15	
0385	Revise testing to prevent negative pressure in the S-IC LOX tank	2-15	MILA 1, 2, 3 MTF 1
0386	Change spring material in Whittaker LOX prevalves (20M32010) and accomplish a modified requalification test	8-15	
0387	Revise flight instrumentation to verify stage performance and environment	3-15	
0388	Redesign electrical disconnect bracket (60B67324-7)	3-5	
0389 * Cancelled	Modify filter manifold delta pressure transducer (D119) tubing	3-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0390	Provide backup LOX bubbling system in the S-IC pneumatic console		MTO 1 MAB MILA 1, 2, 3
0392	Delete the S-IC base air scoop	2-15	
0394	Provide a manual means to fill the stage helium bottles		MAB MTO 1 MILA 1, 2, 3
0395	Change O-rings in 65B23278 solenoid valves		MSE 1, 2 MTF 1 MILA 1, 2, 3
0396 * Cancelled	Block debris valves in S-IC intertank reconnect assembly LOX fill and drain lines in the open position		MILA 1
0397 * Cancelled	Change the material on the 60B41044 LOX fill and drain elbows	6015	
0398	Provide for control of fuel and LOX loading electronics calibration commands from propellant tanking computer system	3-15	MSE 1, 2 MTO 1
0399	Modify installation of acoustic vibration measurements utilizing 60B67632-XXX coaxial cable assembly	3-5	
0400	Modify S-IC intertank umbilical reconnect assembly to include a backup retract capability		MILA 1, 2, 3
0401	Provide locking and position indicating mechanism for S-IC pneumatic console and forward umbilical service unit manual ball valves		MTF 1 MILA 1, 2, 3 MAB
0405	Modify the umbilical coupling for the oxidizer suction line bubbling system	3-15	MSE 1, 2 MTF 1 MILA 1, 2, 3
0406	Modify TV objective lens housing assembly	2-3	
0407 * Cancelled	Readjust outboard LOX and fuel depletion system timers	2	
0409	Provide hardwire engine actuator position interlock for engine cutoff	3-15	MSE 1, 2 MTO 1
0410	Modify engine cutoff circuitry to reduce potential of premature shutdown	3-15	MSE 1, 2 MTO 1

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0411 * Cancelled	Provide drain for servoactuator rod seal leakage	2-15	
0412	Replace Southwestern Industries gage and absolute pressure switches with Consolidated Controls pressure switches	3-15	MILA 1, 2, 3 MAB
0414 * Cancelled	Replace bolts in fairing heat shield access panel	3-15	
0415	Replace 50M04049 MOOG servoactuator with 60B84500 MOOG servoactuator	2	
0419	Provide new latch on the S-IC intertank umbilical reconnect assembly		MILA 1, 2, 3
0421	Solder RF coaxial shield braid to connect shield clamp	3-8	
0423	Visual identification for S-IC stage ordnance systems	3-15	
0425 * Cancelled	Modify fuel tank vertical internal access equipment		KSC Genl
0426	Identification of equipment containers to unit 120	4-15	
0428 * Cancelled	Propellant depletion system timer setting for S-IC-3 (B/P 30)	3	
0429	Add instrumentation for analysis of vehicle release condition	3	
0430	Change frequency of telemetry links	6-15	MSE 1, 2 MTO 1
0432	Modify LOX and fuel prepressurization systems		MILA 1, 2, 3 MTO 1 MAB
0437	Lockwire threaded connectors which do not have drilled holes for lockwiring	3-15	
0441	Provide additional protection for components vulnerable to damage from the S-IC/S-II separation environment	3-15	
0442	Install helium injection POGO suppression systems	3-15	MSE 1, 2 MTO 1
0444	Increase forward umbilical service unit flow capability		MILA 1

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0848 R1	Replace pressure gage in forward umbilical service unit		LUT #1, #2, #3
0866R1	Modify heater blanket assemblies	1-3	
0867 R1	Modify base heat shield installation	1-15	
0868 R1	Modify connector hex nut	3-5	
0869 R1	Eliminate interference on base air scoop measurement installation	1-5	
0870 R1	Modify base heat shield support angle installation	1-4	
0871 R1	Correct bolt lengths on lower fairings	3-15	
0873 R1	Modify support installation to allow installation of the recoverable camera	2, 3	
0874 R1	Correct bolt length on thrust structure base air scoop installation	1-15	
0875 R1	Provide pilot relay for heater power contactor in S-IC pneumatic console		MILA 1, 2, 3 MTF 1
0876 R1	Modify ground cable in TV camera system	2, 3	
0877 R1	Modify retrorocket initiation system	1-15	
0879 R1	Modify tube assembly in the pneumatic console		MILA 1
0880 R1	Eliminate an out-of-tolerance condition in the LOX leakmeter measurement F45-118	1-5	
0883 R1	Correct bolt length callout on servoactuator boot installation	1-15	
0884 R1	Modify length of cable assembly 115W305	1-5	
0885 R1	LOX fill and drain valves (B-239, B240) control valves reversed cables		MILA 1, 2, 3 MAB MTF 1
0887 R1	Calorimeter purge line clamp	2-5	
0889 R1	Modify S-IC intertank umbilical to delay closure of debris valve		MILA
0890 R1	LOX and fuel loading electronics unit calibration cables	1,2	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
0891 R1	Heat shield panel installation	2, 3	
0892 R1	Electrical installation forward skirt	2, 3	
0893 R1	Eliminate leakage in LOX pressure sensing line		MILA 1, 2, 3
0896 R1	Housing Assembly aft 1 and 2		MILA 1, 2, 3
0897 R1	Rebonding of antifriction plates	2	
0900 R1	Fuel delivery system installation fuel tank	1-15	
0902 R1	Cable and instrument installation thrust chamber unit 105	2-5	
0903 R1	Engine fairing blanket assembly	2-15	
0904 R1	Cable and instrumentation installation - units 101 and 102	2-4	
0906 R1	Measurement installation fin B	2, 3	
0907 R1	Propellant dispersion system installation and retrorocket initiation system	2-15	
0908 R1	Change bolt callout	2-15	
0913 R1	Base heat shield bracket misalignment	3-15	
0914 R1	Rework fuel ordnance cowling and revise ordnance installation requirements	2-15	
0916 R1	Rework thrust chamber insulation	2-5	
0918 R1	Revise fin and fairing nut callouts	3-15	
0920 R1	Replace insulation bracket covers	2-9	
0929 R1	Disconnect position switch cables on vent and relief valves	2	
1214 G	Increase accuracy of GOX flow control valve pilot pressure measurement		MSE 1, 2
1219 G	Revision to stage handling equipment (MAB VAB)		MAB
1221 G	Utilize RCA 110A as primary engine test programmer		MTF
1224 S	Correct errors on LOX anti-vortex documentation	10-15	

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
1225 S	Replace roller cams on LOX interconnect support bracket installation	4-15	
1226 G	Modify MTF rotational brace		MTF 1
1227 G	Modify the MTF hydraulic terminal equipment		MTF 1
1232 G	Modify pin puller assemblies and adjustment linkage assembly at MTF		MTF 1
1233 G	Modify the area contamination detection system		MSE 1, 2
1235 S	Provide self-aligning capability for engine fairing turnbuckles	5-15	
1236 S	Redesign rate gyro heater blanket assembly	10-15	
1237 S	Relocate engine actuator electrical filter assembly	5-15	
1238 S	Revise S-IC servoactuator thermal insulation documentation	10-15	
1239 S	Revise 60B19612-1 static firing antifriction plates to facilitate removal	6-15	
1240 G	Provide capability for remote pressurization and venting of the GOX ducting system		MTO 1
1243 G	Modify aluminum forward handling ring test requirements	7-15	
1244 S * Cancelled	Provide new presampling filter and modified power supply cards	-15	
1245 S	Eliminate solder joints susceptible to cracks in electrical distributors	10-15	
1246 G	Provide temporary environmental protection for servoactuators		MTF 1
1247 S	Protect flight instrumentation parts from damage during manufacturing and test	6-15	
1248 G	Provide a new step ladder on the intertank horizontal internal access platform		MSE 1, 2, 3
1249 S	Modify Carter solenoid valves to inhibit corrosion	5-15	
1250 G	Revise forward stabilization system actuator seal system		MTO 1

CHANGE NO.	DESCRIPTION	EFFECTIVITIES STAGE	GSE
1251 G	Revise forward stabilization system hoisting mechanism		MTO 1
1253 G	Modify GHe primary regulation module of the S-IC pneumatic console		MTO 1
9226	Provide hardware to maintain the F-1 engine mock up to conform to PRR 1162		
9231	Utilize two GFE steel forward handling rings on S-IC flight stages	1	
9241	Combine GSE and stage loads on the GSE power supply		MTO 1 MSE 1, 2
9242 * Cancelled	Revise proof load valves and specify periodic proof testing of S-IC lifting link and rotating brace assembly		MTO 1
9243	Addition of anti-drainback valve to S-IC MAB hydraulic power supply unit		MAB
9255	Provide special handling equipment for KSC		KSC
9290	Install a steel handling ring on the S-IC-F		
9305	Modify mechanical automation breadboard Carter solenoid valves		MAB

APPENDIX G

SYSTEMS TEST - MTO
DOCUMENT STATUS REPORT

DOCUMENT NO.	DOCUMENT TITLE	STATUS
D5-10016-1	BMTO EMERGENCY CONTROL PLAN	IN WORK
D5-11789-005	STAGE SEQUENCE/OPERATIONS PLAN FOR SATURN S-IC-5	COMPLETED
D5-11789-006	STAGE SEQUENCE/OPERATIONS PLAN FOR SATURN S-IC-6	COMPLETED
D5-11789-100	STAGE SEQUENCE/OPERATIONS PLAN FOR SATURN S-IC — PROCEDURES AND INSTRUCTIONS FOR PROCESSING STAGES AT MTF	COMPLETED
D5-13034	S-IC SPECIAL TESTS	COMPLETED
D5-13034-3	LOX EMERGENCY DUMP LINE TEST	CANCELLED
D5-13034-38	S-IC BOOSTER STORAGE BUILDING FLOOR SETTLEMENT TEST	COMPLETED
D5-13034-39	POST EMERGENCY DRAIN LINE COLLAPSE, SPECIAL RP-1 TRANSFER TESTS	IN WORK
D5-13034-40	FUEL TANK DRAIN TESTS S-IC-D	IN WORK
D5-13034-41	TEST OF S-IC STATIC TEST STAND VENTILATION	IN WORK
D5-13034-42	RCA/110A BECKMAN COMPUTER PROGRAM DEVELOPMENT	COMPLETED
D5-13034-43	TEST OF HOLDDOWN ARM ANTI-FRICTION PLATE	IN WORK
D5-13034-45	ENVIRONMENTAL TEST, S-IC EAST OBSERVATION BUNKER	IN WORK
D5-13034-46	IN-PLACE GN_2 ONE-HALF INCH BY-PASS LINE TEST	INWORK
D5-13047-47	HELIUM FLOW CONTROL VALVE FLOW RESPONSE TEST	IN WORK
D5-13034-48	SIMULATED GN_2 ONE-HALF INCH BY-PASS LINE TEST	IN WORK

DOCUMENT NO.	DOCUMENT TITLE	STATUS
D5-13743	FACILITIES MAINTENANCE PLAN - MTF	CANCELLED
D5-13781	FACILITIES MAINTENANCE RECORD SYSTEM	CANCELLED
D5-13970	CONTAMINATION CONTROL OF S-IC SYSTEMS AT MTF	IN WORK

GLOSSARY

AS Apollo/Saturn

BATC Boeing Atlantic Test Center, KSC, Florida

BICAR Boeing Investigation and Corrective Action Request

CAM Change action memo

CAR Corrective action request

CCB Configuration Control Board

CCP Contract change proposal

CDDT Countdown Demonstration Test

CDF Confined detonating fuse

CDR Critical design review

CEI Contract end item

CID Cable Interconnect diagram

CLASS I CHANGE:

If an engineering change deviates from the contract and must, therefore, be covered by contract revision, it is Class I. All Class I changes are processed by Engineering Change Proposal. Class I changes are specifically identified as such if one or more of the following is affected: (1) Part I CEI Specifications; (2) Contract price or fee and contract guarantees, delivery, or test schedules; (3) Changes to Part II CEI Specifications if any or the following are affected - interchangeability, electrical interference, present adjustments, interfaces, computer programs, change in vendors, retrofit, requalification testing, and any change affecting high energy nuclear radiation sources.

CLASS II CHANGE:

All changes that are not Class I.

C/O Checkout

CPFF Cost plus fixed fee (contract)

CPIF Cost plus incentive fee (contract)

CRT Cathode ray tube

CSA Computer Sciences Applications

CSM Central Stores Michoud

CY Calendar year

DAF Data Acquisition Facility

DDAS Digital data acquisition system

DEE Digital events evaluator

DI/DO Discrete in/discrete out

DRD Document requirements description

DRL Document requirements list

DTS Data transmission system

EAMR Engineering Advance Material Releases

EAPL Engineering assembly parts list

ECM Engineering change memorandum

ECP Engineering change proposal

ECPR Engineering change proposal requirements

ECS Environmental control system

EDS Emergency detection system

E/E Electrical/electronic

EITP End item test plan

EMC Electromagnetic compatibility

EMO Equipment management organization

EMPL Engineering master parts list

EO Engineering order

EPRR Engineering parts release record

EQA Equipment quality analysis

ERS Experience retention study, also Equipment record system

FACI First article configuration inspection

FLSC	Flexible linear shaped charge
FM	Frequency modulated (modulation)
FY	Fiscal year
GETS	Ground Equipment Test Set
GFE	Government furnished equipment
GFP	Government furnished property
GN_2	Gaseous nitrogen
GOX	Gaseous oxygen
gpm	Gallons per minute
GSE	Ground support equipment
HLS	Hydraulic load simulator (MAB)
HPA	High pressure air
HPG	High pressure gas
HPIW	High pressure industrial water
HPSU	Hydraulic power supply unit
ICD	Interface control documentation
ICE	Instrument calibration equipment
IDEP	Interservice Data Exchange Program
IRN	Interface Revision Notice
ITGE	Integrated telemetry ground equipment
JOD	Joint occupancy date
KSC	Kennedy Space Center, Florida
KSI	Kips per square inch
KVA	Kilovolt ampere
LH_2	Liquid hydrogen
LN	Liquid nitrogen
LOX	Liquid oxygen
LSB	Launch Systems Branch
LSBRS	Launch Systems Branch records system
LUT	Launch Umbilical Tower
MAB	Mechanical automation breadboard
MAF	Michoud Assembly Facility
MAR	Maintenance Action Revision
MB	NASA/MSFC-Boeing (jointly issued specification, drawing, or part number)
MBR	MSFC/Boeing relay (last letter represents type of part)
MCMRP	Minimum configuration management requirements plan
MCL	Measurement control laboratory
MDS	Malfunction detection system
ME	Manufacturing engineering
MF	Medium Frequency
Michoud	Michoud Assembly Facility, New Orleans, Louisiana
MIG	Mechanical inert gas (welding process)
MRB	Materiel Review Board
MSC	Manned Spaceflight Center, Houston, Texas
MSE	Manufacturer's support equipment (GSE to support manufacturing facility)
MSE I	Manufacturer's support equipment - this test complex used for PSC and refurbishment of stages.
MSE II	Manufacturer's support equipment - this test complex used for PMC of stages.
MSFC	Marshall Space Flight Center, Huntsville, Alabama
MTF	Mississippi Test Facility, Mississippi
MTO	Mississippi Test Operations (Boeing Systems Test organization responsible for MTF activities)

NASA	National Aeronautics and Space Administration
NC	Numerical Control
NDT	Nondestructive Test
N/H	Next Higher Part Number
N/HE	Nitrogen/Helium
NPSH	Net positive suction head
OAT	Overall test (procedure)
ODIS	On-line data input system
ODOP	Offset Doppler system
PAM	Pulse amplitude modulated
PAR	Part analysis report
PART I	CEI specifications - set forth "detail design and performance requirements" for S-IC-F, S-IC-1 through S-IC-10, and all deliverable GSE at KSC.
PART II	CEI specifications - set forth "drawings and test requirements" for S-IC-3 on (does not affect S-IC-F, S-IC-1, S-IC-2, or deliverable GSE)
PCA	Production control area
PCC	Program control center
PCM	Pulse code modulated
PD	Program Directive
PERT	Program evaluation and review technique
PMC	Post-manufacturing checkout
P/N	Part Number
PRR	Production revision record (a class II change)
PSC	Post-static checkout
Q&RA	Quality and Reliability Assurance
QC	Quality control
QMT	Quality Maintenance Test
R&D	Research and development
RACS	Remote automatic calibration system
RAM	Reliability Analysis Model
RDC	Reliability Data Center
RDSM	Remote Digital Sub-Multiplexer
RF	Radio frequency
RFP	Request for proposal
RP-1	Fuel (kerosene)
R-QUAL	Quality Laboratory, MSFC
R-TEST	Test Laboratory, MSFC
SA	Supplemental Agreement
SCN	Specification Change Notice
SDC	Status Display Center
SE	Support Equipment
ST-MTF	Systems test - MTF
TCC	Test control center
TIG	Tungsten inert gas (welding process)
T/M	Telemetry
TVC	Thrust Vector Control
UCR	Unsatisfactory Condition Report
UER	Unplanned event record
VAB	Vertical Assembly Building
VISTA	Visual Task Analysis
WAC	Work Authorization Change
Δp	Delta p, differential pressure